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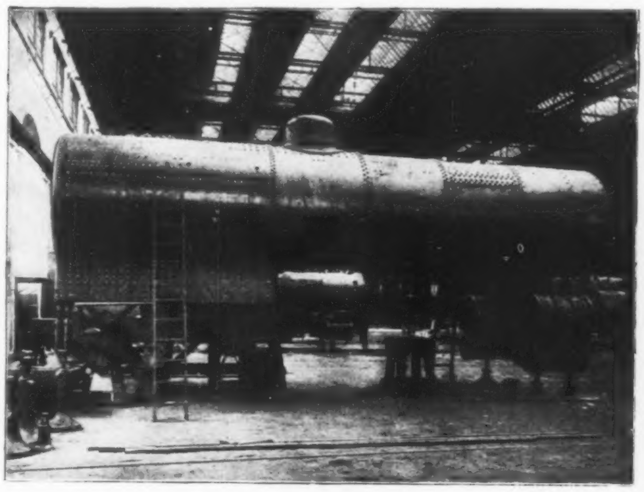
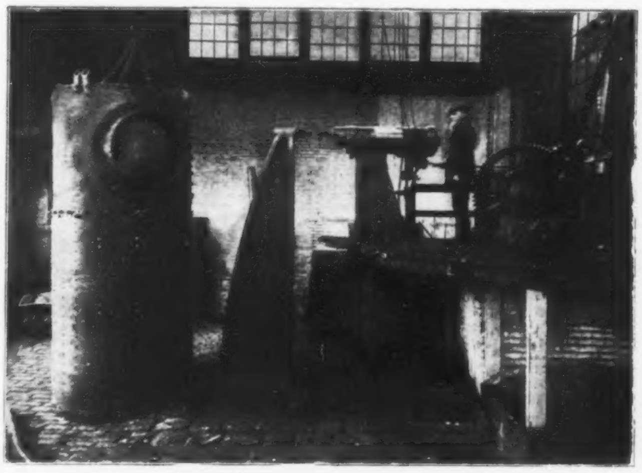


BOILER IN ERECTING SHOP.



BOILER RIVETING MACHINE.

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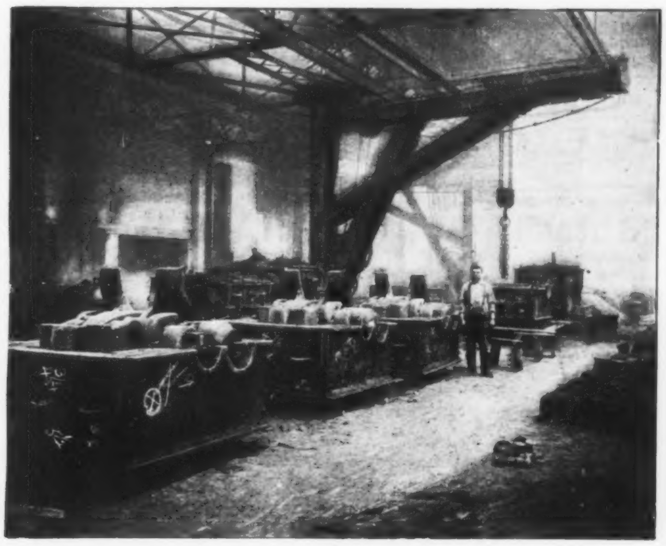
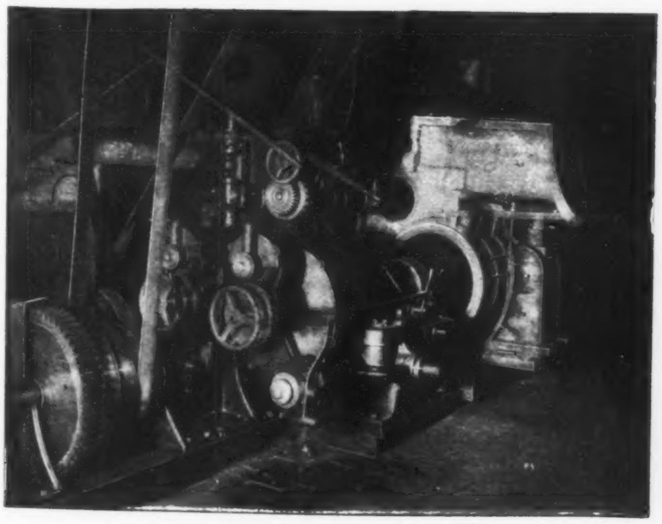


FLASKS FOR CASTING CYLINDERS.



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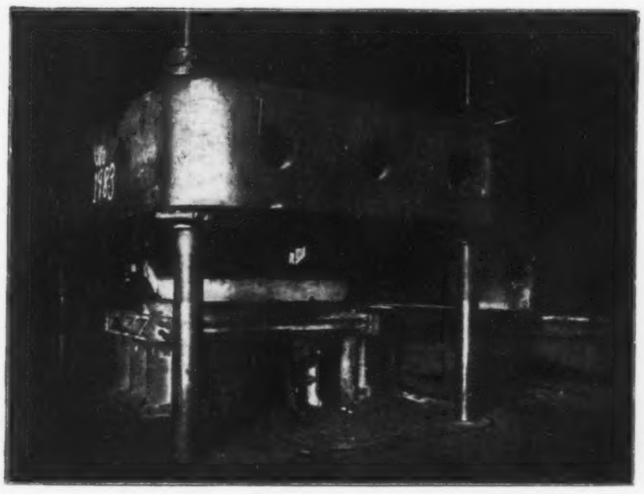


HYDRAULIC FLANGING PRESS.

THE BUILDING OF A MODERN LOCOMOTIVE.

THE BUILDING OF A MODERN LOCOMOTIVE.*

CONSTRUCTION OF BOILER.

In order to properly understand the building of a modern locomotive, and comprehend the many operations necessary to produce the finished machine, it is essential to visit a large locomotive works, and actually view the process as there carried on. This article will only attempt in a general way, to outline the process with the help of a number of illustrations which, it is hoped, will make the description clearer.

The pictures here shown are from photographs taken at the Baldwin Locomotive Works, in Philadelphia, and the accompanying description applies to the methods employed at those shops. It must suffice, in this connection, to note that these works are the largest of their kind in the world; that they employ over 8,000 men; have a rated capacity of 1,000 locomotives per annum, and actually turned out over 1,200 in the year just closed, at the end of which the total output had been about 18,500 engines, over 1,500 of them being four-cylinder compounds. The history of the works, since their founding by Matthias Baldwin in 1831, has been one of real progress from the start, and to-day Baldwin locomotives are doing effective work all over the world. Lack of space, unfortunately, prevents our taking up, in detail, the subject of shop practice as employed at these works.

In describing the building of a locomotive, we will take up the subject under four heads, viz., First, boilers; second, cylinders; third, frames, wheels and other parts; and fourth, assembling or erecting.

While all parts of the locomotive have undergone a remarkable development during recent years, it is the boiler which, to-day, is receiving the greatest amount of attention. It is becoming more and more recognized that the ability of a locomotive to maintain a high average speed on long hauls, depends chiefly upon the capacity of its boiler; and the problem of getting increased boiler power—and especially more grate area—is one of the knotty questions confronting the up-to-date locomotive designer.

Steel plate is used exclusively in modern American locomotive boilers, although in many engines for foreign export the firebox is of copper. The steel is received at the works in sheets of various sizes and thicknesses, some of them over twenty feet long, this size being required to form a ring for the very large boilers now in use. The plates are moved about in the shop by means of overhead traveling cranes; this arrangement being made easier since most of the tools are driven by separate electric motors, thus avoiding overhead belts.

The first operation is to prepare the plates for punching and drilling. The sheet is laid on a table, and the centers of the holes marked out by means of standard gages. In cases where a plate is to be flanged, the holes for the flange are not marked off until after that operation is completed, otherwise a perfect match with corresponding holes in other plates could not be assured. Straight lines, along which rivet holes are to lie, are first laid down, the centers of the holes being then carefully spaced, so that their position can be determined with absolute accuracy. In the case of sheets for the barrel of the boiler, plates which lap are divided into the same number of equal spaces, and the rivet holes located at the points of division, so that, provided the lengths of the sheets are correctly laid off, the holes are sure to match.

The centers having been accurately located, the next operation is to form the holes, which is done either by punching or drilling, according to specifications. Foreign orders require that all holes must be drilled; but in American practice it is customary to use the punch to a large extent. In all cases where the punch is used, the holes are made smaller than the required diameter, and subsequently reamed out to size. All flanged plates are annealed, and all flue sheets after punching are straightened and annealed, and then the holes are reamed to gages by special machinery. In the case of rivet and stay-bolt holes, the reaming is done with small portable pneumatic machines.

Many of the punching machines are driven by separate electric motors, and they are of various designs to handle different sizes of plates. Above each machine is a crane, from which the plate is hung by means of chains. The punch has a projection on its under side; several men guide the plate until this projection catches in one of the center punch marks, when, by moving a lever, the machine is put in operation, and promptly bites out the metal.

All sheets on which flanging is to be done are now sent to the flanging shop. As far as possible, flanges are made on hydraulic presses.

Flanges of odd shape, for which there are no dies to form them on the press, are made by hand. The edge of the plate is placed in a fire forced by an air blast, and, when the desired heat is obtained, is laid on a form and bent by means of heavy wooden mallets. In bending on a straight edge, the plate is clamped to the form, and one heat usually suffices for the operation. Flanging by hand is naturally a slow process, as three feet is about the greatest length that can be heated and bent at once; and it is only when suitable dies for the hydraulic press cannot be profitably made, that this system is employed.

The plates are now sent back to the boiler shop where they are prepared for assembling. The roughened edges of the flanges, whenever it is possible to do so, are planed off on special machines; but in most cases the edges are dressed by chipping with a hammer and chisel. In the meantime, the plates for the barrel of the boiler have been trimmed off in a large shearing press, and the edges then planed on a plate planer, after which they are ready for the bending rolls. Each of these machines consists of three rolls, power to turn them being furnished by an electric motor. The two lower ones are on the same plane, while the upper one is adjustable as to height, its position being controlled by large screws operated by gears, one screw being placed at each end. By altering the position of the upper roll, the plate can be bent to any desired radius. The workmen use a sheet-iron templet as a gage, and can tell accurately when the proper curvature has been reached.

The plates, having been bent and flanged, are ready to be assembled for the riveting machines. The rivet holes in the flanges are laid off by temporarily assembling the piece with others which have already been punched and drilled, the holes being thus made to match exactly. Special punches and drills, with the tools traveling horizontally instead of vertically, are used to pierce the flanges.

The boiler is now assembled in two principal parts, viz., the smokebox and two front rings, and the third ring and outer shell of the firebox. The sheets are temporarily united with bolts. The mud ring, which has been formed of wrought iron, with joints welded throughout, and drilled for riveting to the firebox, is fitted to the inside shell; which is not united with the outside shell until after the machine riveting has been finished.

The riveters used at the Baldwin works are operated with hydraulic power. Each die is placed on the top of an upright; and these, in the largest machines, are tall enough to lower the assembled boiler between them, so that the riveting can be started at one end, and worked all the way to the other by simply raising the shell, which is suspended, by means of chains, from overhead travelers. The movable die of the riveter is always on the outside of the boiler shell, while the rivet head is formed against the fixed die on the inside. These machines are practically noiseless. Each machine has its own furnace for heating the rivets. Three men swing the boiler into position and handle the riveter, while a boy looks after the furnace. One of these machines, with a boiler standing beside it, is shown. The shell is hung, by means of chains, from travelers placed under the roof of the shop, and its manipulation is a very simple matter, as it is perfectly free to be raised or lowered, or turned to any desired position. The illustration shows plainly the cylinder and piping for conveying water to the ram of the movable die; while behind the operator is the furnace in which the rivets are heated.

When the boiler leaves the machine, most of the riveting has been done, although the inside shell of the firebox has not been united with the outside, and the front and back sections are still separated.

A 25-ton traveling crane now hoists the several parts to the second floor of the shop. The rear half of the boiler is placed upside down, and the inside shell of the firebox, with the mud ring and the back head, are assembled into it by means of bolts and nuts. The mud ring is riveted by means of a small hydraulic machine, which is hung from a crane so that it can be easily moved about. One of these riveters can be plainly seen, suspended above a boiler on the left-hand side of the illustration. In cases where the back head is flanged *outward*, as is often done in wide firebox boilers, the machine riveter can be used in securing it to the shell; but where it is flanged *inward*, hand riveting must be resorted to, as the inner ends of the rivets are not accessible to the machine.

The inside firebox, mud ring and back head having been riveted to the outside shell, the boiler is placed on suitable pedestals, right side up, and the front half of the barrel—previously finished—is assembled with it. This operation is sometimes performed while the boiler is still on its back, as in the case of those shown in the foreground. These boilers, it may be noted, have only two rings in the barrel, and in the boiler on the extreme left they have not yet been riveted together. The seam where the halves unite is riveted up by hand, the heads being formed on the outside, in a die which is struck with heavy hammers. In the meantime, the stay-bolt holes are being threaded with small portable pneumatic tapping machines. The stay bolts are of iron, threaded at each end, the middle being turned down to a diameter equal to the inside diameter of the thread. In the center of the bolt is a small hole, leakage through which at once occurs if the bolt breaks. On the outer end of each bolt is a square head, with which it is screwed in by means of a special wrench. The head is then cut off with a special machine, and the bolt hammered down at each end, while cold, with blows from a heavy hammer. In foreign work, where copper fireboxes are frequently used, the stay bolts are usually of copper, but similar in all other respects to the iron ones just described.

The firebox in a modern boiler is usually radial-stayed all around, although, in some types, the crown sheet is still supported by means of crown bars and sling stays, the saddles for the stays having been machine riveted to the roof and bolted to the crown sheets, previous to assembling.

The dome, in the meantime, has been riveted to a flanged ring of pressed steel, previously united with the shell by the hydraulic machine. The body of the dome is formed of a sheet of boiler plate, which has been punched for riveting to the dome top, then bent to the proper radius, and lap-welded on a form by blows struck with heavy hammers. The dome top and base ring are of pressed steel, being formed on a small hydraulic machine. The cap is then drilled to match the holes in the body of the dome, after which the two are assembled, the holes being reamed out together with a pneumatic drill, and subsequently riveted on a hydraulic riveter. The dome base is accurately machined to fit the boiler and is drilled in position.

As the plates are assembled, the sheets are calked at the points to prevent leakage. This is done by means of a tool with a rounded edge, which forms a fillet and pinches the plates tightly together without cutting the metal. This method of calking, known as the "concave," was devised by Mr. J. W. Connery, of the Baldwin works, and has proved highly successful.

The work on the boiler shell is now practically completed. The riveting is finished; the stay bolts are all screwed in; the dome has been mounted, and the tube sheets inserted. The boiler is now sent to the erecting shop, the cut showing its appearance as it is received there. The boiler is intended for a large compound Consolidation engine. The ring just in front of the dome is hand riveted; practically all the rest of the work has been done by machine, except that around the back head, which sheet, as the illustration shows, is flanged inward, thus preventing the use of the machine riveter. It will be noticed that nearly all the seams, including the mud ring, are double riveted. The arrangement of a butt joint, with four rows of rivets through the outside covering strip, and six through the inside, is plainly shown just back of the smokebox. The extension front is secured to the barrel by an internal ring, so that there is a smooth finish on the outside. It will be noticed that this boiler, as is usually the case in modern practice, is built "telescopic," each ring in the barrel lapping on the inside of the one next back of it, the smokebox ring excepted.

It yet remains to insert the tubes and various mountings, and to test the boiler for leakage. These operations will be described in the paper on "Erecting."

The next section of the article will deal with the locomotive cylinder and its method of construction.

THE CYLINDERS.

Although pressed and cast steel are now being very extensively used in locomotive construction, there is one part which is universally made of cast iron, and that is the cylinders.

The foundry at the Baldwin works, where cylinders, wheel centers and other parts are cast, extends the length of a city block. Down the center of the shop are placed seven jib cranes, and in addition there are several small traveling cranes, to assist in handling the molds and ladles.

There are three cupolas, each having a capacity of fifty tons of iron at one heat; the amount actually used in this shop being about 135 tons per day.

Cast iron is graded by chemical analysis only, and that used for cylinders contains only about one and seven tenths per cent of silicon, as it is necessary to have this part of as hard a material as can conveniently be worked. The grade of iron is regulated by the relative amounts of "pig iron" and "scrap" which are mixed to produce it. Before using the pig iron, samples are sent to the laboratory for analysis, in order that its composition may be accurately determined. The scrap comes to the foundry in the shape of old and spoiled castings, which are broken into small pieces by raising a heavy weight and allowing it to drop on them. The quality of the scrap can frequently be determined with sufficient accuracy, by a simple inspection, but when this cannot be done, it is also sent to the laboratory for analysis.

One of the cupolas, mentioned above, is used exclusively to produce the iron of which cylinders are made. The cupola is simply a stack built of metal plates and lined with fire brick, and fed through a charging door located about twenty feet above the ground; the charging being done from a gallery, to which trucks loaded with pig, scrap, and coke, are hoisted by means of a crane and an elevator.

The operation is started late in the morning by building a coke fire in the cupola, 1,800 pounds of fuel being used to form a bed, on which are placed alternate layers of a mixture of pig and scrap, and coke. The relative amounts of pig and scrap used depend upon the result of the analysis of the same, and different proportions must be used according to their composition, to produce the grade of iron desired. The coke is of the best quality, the usual ratio, by weight, of coke to iron, being about as one to eight. A small amount of lime stone is added from time to time, in order to form a "flux" to carry off the impurities in the iron.

About two hours after the fire has been lighted, the cupola is filled to the bottom level of the charging door. An air blast, produced by a large blower driven by a steam engine, is now forced into the cupola through two openings, called *tuyeres*, located about five feet from the bottom, and in the course of perhaps half an hour, the cupola is ready for tapping. The tap hole is a small opening closed with a clay plug, and discharging into a spout from which the metal runs into the ladles; the slag, containing the impurities, running out through another opening, located above the tap hole and on the opposite side of the cupola.

The molders in the meantime have been getting ready the molds in which the cylinders are cast. The high and low pressure cylinders for one of the new Baltimore and Ohio Consolidation engines are respectively fifteen and one-half and twenty-six inches in diameter, and a casting for cylinders of this size and type requires a pattern built up in three sections, the lines of division running through the center lines of the high pressure cylinder and steam chest, and the center line of the low pressure cylinder, respectively. The flasks are built of cast-iron plates, bolted together at the corners, and having a trunnion at each end, so that they can be conveniently handled by the crane. A number of molds of this kind, in course of erection, are shown. It should be explained, in this connection, that in the Vauclain compound locomotive the high and low pressure cylinders, and the steam chest, are cast together with half the saddle; the valve being of the piston type, and working in a cylindrical bushing, which is forced into the steam chest after the casting is finished, as will be explained hereafter.

The casting weighs about 8,700 pounds, and the pouring is done from a ladle having a capacity of 12,000 pounds. This ladle is not filled directly from the cupola; a smaller one is put under the tap hole, and in it the molten iron is transferred to the large ladle, two fillings of the small one being required. The slight cooling of the metal, while the small ladle is being filled a second time, is rather an advantage, as the metal is too hot to be poured as it runs from the cupola. The ladle is swung to the mold on one of the large cranes, and tilted about a horizontal axis by means of a handle connected with worm wheels. The metal is poured steadily until the mold is completely filled; then as it shrinks when it begins to cool, a little more is added to keep the mold full. The pouring being finished, the mold is allowed to stand about twelve hours, before the casting is taken out of it; and after it is removed it stands for a day before the cleaners begin their work. A great quantity of sand adheres to the casting; this is all carefully removed and projections on the surface are chipped off, giving the piece a fairly smooth and clean appearance.

The cylinder now leaves the foundry, and the work of machining it down to size is begun. The first operation is to plane off the end surfaces, so that the casting can be more accurately laid out before it is sent to the boring machine. The piece is set on a planer with the axis of the cylinder vertical, and a

* Reprinted from the Brotherhood of Locomotive Firemen's Magazine.

cut is taken off the end surfaces surrounding the cylinders and steam chest at both ends of the casting. It is then placed on a table, and the cylinders and steam chest carefully centered by means of gages, to make sure that the casting will finish to the drawing. The cylinders, when finished, are slightly counterbored at the ends; and circles are scribed on the planed end surfaces to show the diameter of the counterbore. The diameter of the steam chest, when finished, is indicated by similar circles; after which the casting is ready to go to one of the boring machines.

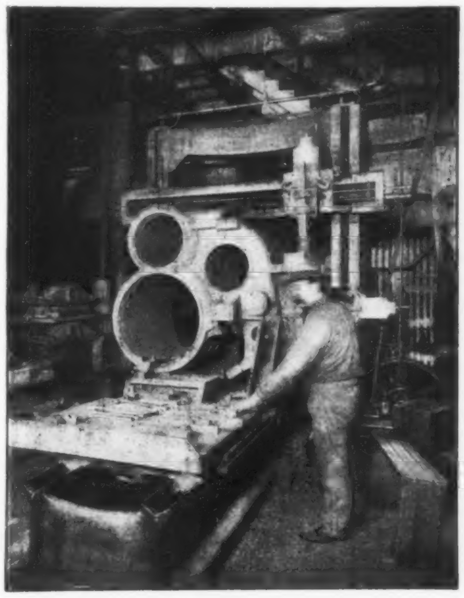
These are most interesting machines, designed for boring out both cylinders and the steam chest at the same time. Our engravings clearly show their principal features. It is seen that there are three boring bars, that for the high-pressure cylinder being fixed, while the one for the low pressure is adjustable horizontally, and for the steam chest both vertically and horizontally; so that the machine can be adjusted to fit cylinders of different sizes. The boring bars can be rotated independently of one another, by means of toothed clutches. Each bar has a slot running almost its entire length, and in the center of the bar is placed a screw which rotates independently by means of separate gearing. The tools are carried on collars, which slip over the bars and have pieces projecting inward through the slots, and taking hold of the screws, so that as the latter rotate, the tools are "fed" along the bars. The slots and collars on two of the boring bars are plainly shown. It will be noticed that the collar on the low-pressure bar is arranged to carry four tools, and by placing them staggered around the collar, four separate cuts are taken at each rotation.

Before placing the cylinder on the machine, the bars are so adjusted that their centers are exactly the same distances apart as are the centers of the cylinders and steam chest to be bored. The bed on which the cylinder is to be placed is now slid out to the right, leaving the boring bars unsupported at their outer ends. The cylinder is placed on the bed, and conveniently supported by means of metal blocks beneath it, a jack being set under the saddle, as shown in the illustration. The bed is now slid back and the position of the casting adjusted, until the distance from the surface of the boring bar to the circles previously scribed on the end faces of the cylinder is exactly the same all the way around the circumference. This distance is measured alike at both ends of the casting, and the latter is clamped in position.

As they come from the foundry, the cylinders are about three-fourths inch less in diameter than they are to be when bored; measuring in this case, fourteen and three-fourths and twenty-five and one-fourth inches for the high and low pressure, respectively. Three cuts are now taken through the cylinders and steam chest; although in the case of the latter, four are sometimes required. In taking the first cut, three tools are usually used on the low-pressure cylinder, and two on the high pressure and steam chest. The second cut, using one tool only, brings the bore almost to finished size; the finishing cut with a broad tool being little more than a scrape. The steam chest in this style of cylinder, is formed with eight circular bridges; and if their diameters are not uniform in the rough casting, four cuts may be necessary. Great care must be taken to obtain exactly the right diameter, which is measured by means of calipers accurately set to gages. Before the casting is removed from the machine the end faces of the cylinders are turned up, and the counterboring finished.

A considerable amount of work remains to be done on the casting after it leaves the boring machine. The inner face of the saddle is planed up to match the face of the opposite casting, and the bearings for the front rails of the frame are also carefully machined. In the case of the cylinder now under notice, there are two front rails, one above and one below the casting. This work is done on large planers in the shop shown in cut. Jib cranes handle the castings, and there is also an electrical walking crane, with which they are transferred from one part of the shop to another.

The casting is now prepared for receiving the cylinder heads, which are also of cast iron, and have previously been drilled with holes for bolting them to the cylinders. The heads are clamped in place, and the holes in the flanges of the cylinders are drilled through gages to match exactly those previously formed in the heads. The seats for the heads are first carefully filed with a fine file, and then ground to a perfectly true face to insure a tight fit. The opening for the steam passage is finished with a concave seat to insure a tight joint, and the seat for the blast pipe is faced up and finished to a true surface. Holes are also drilled in the flange of the saddle, and the two halves are then assembled and bolted together.



A CYLINDER PLANER.

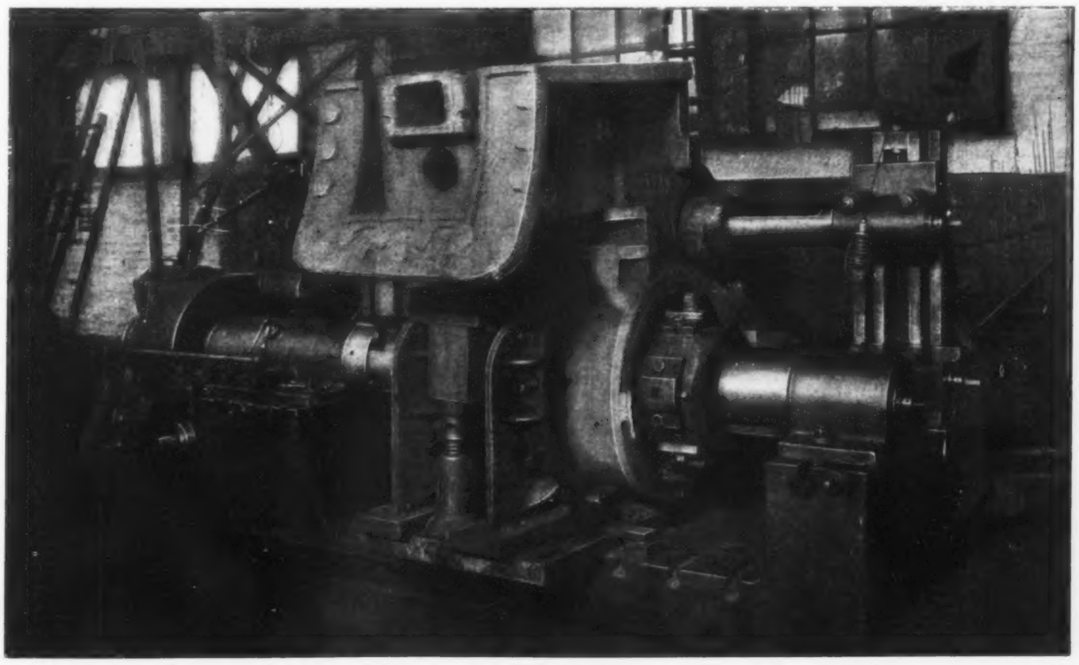
It now remains to insert the steam-chest bushing before sending the cylinders to the erecting shop. The bushing is of hard cast iron, cylindrical in shape, with walls five-eighths inch thick. It has circular ribs to match those in the casting, and twelve longitudinal ribs, which stiffen it and give the valve a good bearing. The bushing is machined to size with great accuracy, in order that it shall properly fit the steam chest; the port openings being finished on a slotting machine, wherever they have not been formed the full size in the casting.

The bushing is now forced into the steam chest under hydraulic pressure by means of a special machine. The ram has attached to it a long rod which passes entirely through the steam chest and bushing, on the outer end of which are placed a cap, secured to the rod by means of a large nut. Pressure is applied to the ram by a small hand pump, and the bushing is slowly drawn into the steam chest, the maximum pressure, about forty tons, being reached during the last part of the operation. The bushing is drawn in until the circular ribs exactly match those in the casting. With this arrangement these important parts can be machined with great accuracy; and when the valve seat becomes worn the bushing can be rebored, and replaced by a new one when it becomes too thin. The cylinders are now practically finished and are sent to the erecting shop for assembling with the other parts of the engine.

The compound locomotive has, for more than ten years, proved itself an economical and reliable source of power in many branches of service. This is especially true of the Vauclain four-cylinder type, invented by a member of the Baldwin firm, and which is now in most extensive use on many of the leading roads at home and abroad. The Vauclain type dispenses with complicated reducing and intercepting valves, and presents an arrangement of cylinders which is exactly similar on both sides of the locomotive, and the power exerted on both sides is exactly the same. The mechanism is very simple, and as nearly like that of an ordinary single expansion engine as it is possible to make it. The compound locomotive has shown, in actual road work, a fuel economy over the simple engine amounting to from ten to twenty-five per cent. This is a matter of importance, especially where loads are exceptionally heavy and engines must be driven to the limit of their capacity to take them over the road on time. There are many large simple engines at work to-day in which the rate of fuel combustion must be forced to such a high figure that it is almost impossible to keep the required amount of coal in the firebox; while similar engines having compound cylinders, with a milder exhaust and lower steam consumption per horse power developed, burn less coal, are more satisfactory, and can, on a critical grade, keep a train moving where a simple engine would probably stall. No one realizes these facts more clearly than does the fireman, who, on many roads, has learned to fully appreciate the compound. One fireman, who runs on a road where the compound has largely supplanted the simple engine in fast express work, told the writer recently that "there was all the difference in the world between firing a compound and a simple engine."

The outlook for the compound locomotive is a bright one, and it is safe to say that, in the near future, it will more and more displace the simple engine in road work, where there are long hauls with heavy loads.

(To be continued.)



THE BUILDING OF A MODERN LOCOMOTIVE—THE BORING MACHINE.

THE SUBSTITUTION OF ZINC WHITE FOR WHITE LEAD IN OIL PAINTING.*

COMMENCING in 1782, Guyton de Morveau gave in the Memoires de l'Academie des Sciences a very extended account of the researches he had made for the purpose of improving painting with oil, and he then hoped that zinc white might replace white lead for interior painting, less for enhancing a luxury, than for protecting the health of artisans and of those who take up their residence too soon in freshly decorated houses. But it was in vain that in 1786 and in 1802 he renewed his efforts for this substitute. A report of Fourcroy, Berthollet, and Vauquelin in 1808 was in the same direction, as well as the important investigations of Chevreul in 1850, in continuation of the results obtained by Leclaire.

The question has since been often considered, but no material progress has been made, and the use of white lead has seemed to be accepted as a necessity of satisfactory and economical work. From the dangers of saturnine intoxication, of which some recent investigations have shown the gravity, it seemed to me that a new and methodical study of the question should be instituted. With this in view, I pursued the following course.

I had prepared by an experienced workman the different products used in painting with oil, the colors and varnishes with white lead base and with a base of zinc oxide; then, taking the former as types, I searched in the laboratory for the causes of the inferiority of products with zinc as base. These causes once determined, I established some formulæ which have been made use of by workmen and secured the same results as products of white lead base.

From these experiments I have deduced the following rules.

For oil colors. 1. For equal weights of solid materials the quantities of the total oil (the oil contained in the ground product plus the oil added) ought to be in the inverse ratio of the densities of the solid materials used, considered in the dry state.

* From the French of M. Ach. Livache. Communication to the Academie des Sciences.

2. The use of a moderate percentage of siccative, say one per cent of the total oil, will dry the color within the time imposed by practice. This result will be obtained with certainty unless the painting suffers some yellowing from the use of such a siccative as magnesium resinate, which, cold, is completely soluble in oil and of remarkable energy.

3. With the indicated quantities of solid material and oil, the covering power of a color whose basis is zinc oxide, will be the same as that of a color with a white lead base. Experiment and calculation show that the weight of solid materials displaced will be in inverse ratio of the densities of these solid materials taken in a dry state.

I have also studied the grounds formed of oil, Spanish white, white lead, or of zinc oxide, with the addition, according to the cases, of spirits of turpentine. These coatings are designed to give a homogeneous and smooth ground, and, above all, to render the surface of the plaster or of the wood impermeable, so that the oil paint, on its application, may not undergo any change of composition, resulting from the absorption of a part of the oil.

These coatings are perhaps the principal cause of saturnine intoxication, either from the necessity of keeping them in prolonged contact with the skin, or from the fine dust disengaged by the dry pumicing.

In comparing these coatings with zinc oxide as base with the coatings of white lead base prepared by an artisan in his accustomed way, and taken as types, I have deduced the following rules:

1. For oil coatings, the ratio of the weight of the oil to that of the total of the solid materials, each of these being converted as weights into Spanish white, according to the volume it occupies, is represented by a constant.

2. The adherence of a coating will result principally from the state of the porosity of the solid substances which enter into its composition.

3. The white lead or zinc white has no other rôle than to serve as an excipient for the oil, which the Spanish white can not completely retain through its insufficient porosity. The experiment shows that the lime carbonate precipitated, which is of extreme fineness and porosity, gives, without addition of white lead or zinc oxide, coatings identical in appearance and adhesion with the coatings of white lead base.

4. The zinc oxide can, without inconvenience, be substituted for the white lead in an oil coating, provided that there is a sufficient percentage, of which it is easy to determine the minimum.

5. The thin coatings and those for moldings, those having to be applied with the brush, can be regarded as derived from an oil coat, rendered more fluid by the addition of a determined quantity of oil and spirits of turpentine.

The objections of net cost and of less durability do not seem well founded; in particular the durability is without doubt identical, even for outside work, on account of the larger percentage of oil, which will give a product more elastic, and consequently less sensible to temperature variations.

THE PRACTICAL BUILDING OF LOWLAND PROTECTIONS.*

By PERCY H. WILSON.

BORDERING the tidal rivers in various parts of our country, and exposed only at low water, are many million acres of marsh-land, covered at high tide by water, and growing aquatic plants and a variety of reeds. The land, when reclaimed through the building of banks to exclude the tide, makes, without exception, the most valuable on the farm; three crops per year being the average, and this without artificial means used by farmers to force their crops.

The building and maintenance of these banks, or lowland protections, has become a most important consideration for the farmer, and, naturally, there have come into use many methods of accomplishing the result. Mud, usually the most convenient material, forms an important detail in all these methods, many revetments being built of that alone. There are cases, however, where mud will not stand alone, and three general methods of protection are mainly used, viz.: (1) Stone, without cement, laid as riprap; (2) timber work; (3) stone with cement, or concrete.

It is my purpose to give a description of the practical building of banks with their protections, accompanied by sketches showing detailed plans of representative constructions in each class, noting briefly the difficulties encountered in each form of construction, and the advantages and disadvantages of each.

MUD REVETMENTS.

History.—The first people to develop the building of large systems of mud revetments were the Dutch, and they, from necessity, are at present probably the most experienced, although we, with our great expanse of lowlands bordering on the Mississippi, are not far behind them either in experience or skill. On our own river (the Delaware) we have much meadow-land exposed to tidal action, and our engineers have become quite expert in the handling of the problems of protection.

Past and Present Methods of Building.—Originally all the banks were built entirely by hand, the men working on the marsh at low water only. The site of the bank was selected well back from the water-way, leaving fifty or a hundred feet "berm." Then a ditch was laid off back of the site of the bank and dug, the material being cast up on the river side of the ditch forming the bank (Fig. 1). Thus with one handling of material the bank was built, and a drainage ditch back of the bank dug; a thing in those days considered as important as the bank itself. The finished product is well shown by the sketch, including the almost universal accompaniment to this form of bank, the muskrat hole.

These old "mud men," as they were called, were heroic workers, and deserve their meed of praise. They are, with the possible exception of ship carpenters, the crankiest set of men I have ever known. But what work they did! Ten hours a day, with a half hour's rest at noon, they stood waist deep in mud and water, casting up neatly cut squares of mud, often at least a distance of ten feet. Several years ago a number of these squares were weighed, and they averaged one hundred pounds each, their weight not varying ten pounds. A skilled man handles from ten to twelve yards of mud per day.

It has gradually come to be recognized that the "backing" or "footing" ditch, as it is called, is not only a disadvantage to a bank, but a detriment. A muskrat will not dig his hole unless he can find water at both ends of it, and filling up the "footing" ditches has greatly decreased the nuisance. Many banks are gutted by these animals, being dangerous to walk on in places, wash-outs occurring frequently, and where not immediately attended to, widening into breaches.

Out of these various troubles has come the modern way of building a bank, viz., by the help of the dredging machine.

Details of Construction.—The majority of meadows which are of any account have these hand-made banks, and at present the principal work is to top them up and stop the breaches. A dredge is taken to within about fifteen feet of the foot of the old bank and material cast over behind it, raising and broadening it and also filling in the "footing" ditch (Fig. 2). This material is put on by installments, time being allowed between each for the material to dry out. The first time, only enough material is taken out to allow the machine to work four or five hours on each tide; the next time, as much mud is put on as will stand, without too much slipping; and the third time, only enough to piece out the bank to the required dimensions. Where the mud slips so badly that all control is lost, a light bank is sometimes erected at the back, about where the proposed slope strikes the meadow. This helps pile up and prevents much loss of material.

It requires great skill and years of experience to say just how much material a bank will stand, and it very often occurs that too much is piled in one place, and either the bank or the contractor (usually both) suffers in consequence. In building the bank the following problems must be solved:

1. To economically operate the dredge, enough material must be excavated to allow it to work at least five hours on each tide.

2. This material must be so placed as to prevent too much loss.

3. The weight of the material must be so distributed as to prevent caving of the old bank.

These three conditions are sometimes extremely difficult to harmonize, and one is, at times, sacrificed to the other. When impossible to reconcile cases 1 and 2, a compromise is effected. Case 3 is never compromised. When the weight of the deposited material becomes greater than the bearing power of the bank, it is the result of a mistake, ignorance, or want of judg-

FIG. 1.—COMMON TYPE OF HAND-MADE BANK.

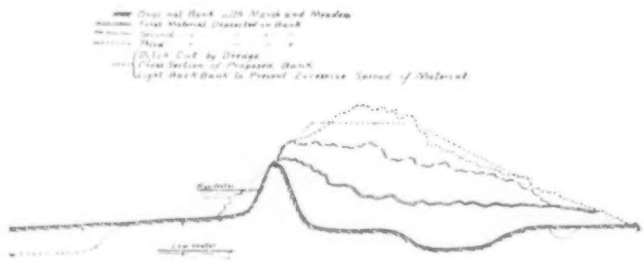


FIG. 2.

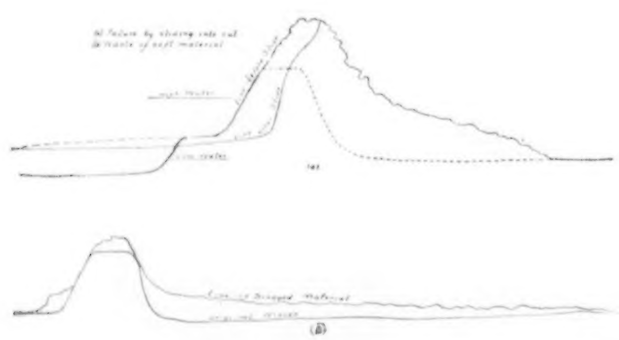


FIG. 3.

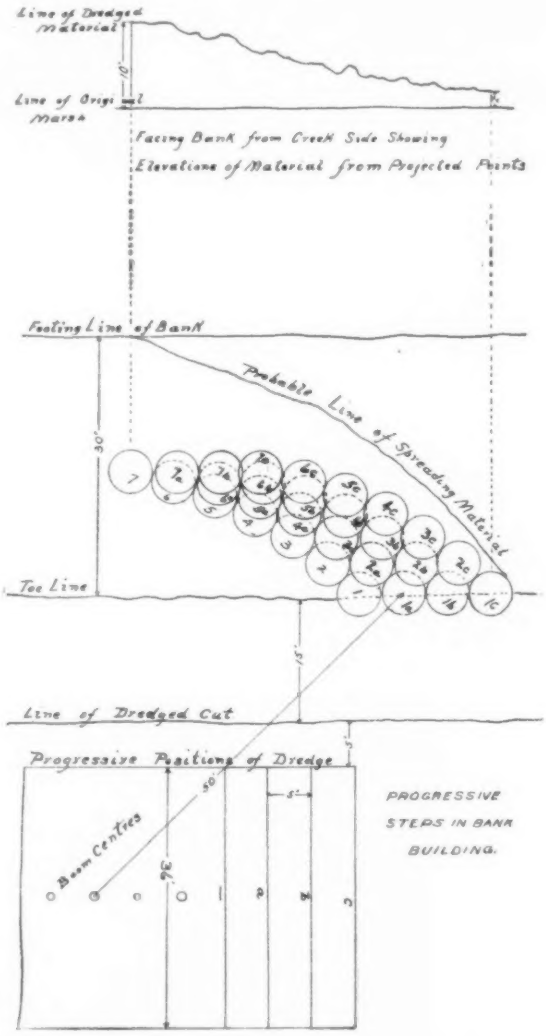


FIG. 4.

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ment; all equally disastrous. There are three general methods in which these slips occur, viz.:

1. The material caving from the center of the old bank and sliding into the cut (Fig. 3): This is due either to the undermining of the bank, i. e., digging too close or too deep in front, or the weight of material placed upon it. These slides are most difficult to guard against, as they rarely occur while the machine is actually in operation. The mud is thrown upon the bank at or about high water, and the bank usually stands while it has this pressure to hold it. When the tide falls and this pressure is withdrawn, the bank breaks. When such a slide occurs, the place is left for a time; then material is placed on either side of the broken portion and it is carefully built up by hand, a slow and tedious process, but reasonably sure. Even then it is not finished at once, but first built above high water, if the bottom does not again commence to slip, and completed when the first material has become set.

2. The material sliding down the back of the bank and out into the meadow beyond the point where the line of the slope hits the meadow (Fig. 3): This in no way endangers the bank, but is of great expense to the contractor, the material being in addition to that provided for by the specifications, and hence not paid for. When these slips occur, the dredge has to make one more trip than would otherwise be necessary to complete the work.

3. The meadow is at times so soft that the material placed upon it settles down in places and pushes the original marsh into the dredged cut. This form of failure is, of all, the most difficult to deal with. The only way such material can be handled is to put a few buckets up at a time, and if more material must of necessity be excavated in order to economically operate the dredge, it must be cast upon the other side of the cut and not upon the site of the bank. At times, when a slide of this kind occurs, the bottom of the creek will rise enough to ground the dredge, which before the slip had ample water in which to float.

When banks are first built, it requires great skill to pile up the material in such a way as to insure its not slipping back into the cut. The first bucket of material is placed nearest the line of the cut, the bucket being allowed to drop hard into the marsh; thus part of the new material is buried in the marsh, which helps to keep this material from slipping (Fig. 4). The boom of the dredge, working practically in an arc of a circle, places each succeeding bucket of mud further around and back, until the limit of swing is reached, where as much material is placed as will stand. When the dredge moves ahead, the first bucket goes on the same line, and next to the first bucket dug on the preceding move. The latest material dug is the most slippery, and even the short time elapsing between moves suffices for the one bucket placed on the toe-line of the bank to become set, thus causing the material to slide away from, instead of toward the cut. In very soft material this method is sometimes insufficient, and a false toe is placed, such as a log, with upright strips driven into the mud to prevent slipping. A small pile of stones is sometimes used in the same way; at times a mattress of brush, straw, or other material is made and mud deposited on top of it.

Referring to Fig. 4, the three letters represent the three moves of the dredge and the corresponding material placed on the bank at that move. It must be understood that only the first seven buckets dug are shown; usually about fourteen are put in place, the other seven as near to the position of bucket No. 7 in each move as possible, the material pushing back at this point to the foot of the bank. Nor will the material remain in the position shown, but will slide and mash down until it reaches the probable line of slide.

When all the material is placed upon the bank, it should be carefully faced and leveled on top, and it is a good practice to level the back face; the slopes most generally used are 1:1 for the face and 1:2 for the back, with various heights and widths on top. This leveling is shovel work, and should be commenced about three days after the material is cast up by the dredge; this time suffices to allow the material to dry enough to give the men good footing and does not allow the material to become sun-baked and hard. Again, when the material is damp, it makes a much better bond with that next it, and forms, after several rains, a good hard bank. If too dry, it at times becomes necessary to use a pick, thus increasing the cost of leveling.

The best practice is then to sow the bank carefully with grass seed and to cultivate a sod; this prevents the mud from washing out at times of rain or freshet, or, in other words, forms a natural protection for the bank.

Another common practice is to plant willow trees along the foot of a bank, that their roots may form a natural protection and tend to hold the bank together. The advisability of this practice is questionable. While it is a protection to a certain extent, yet washouts occur along the roots of these trees, and if many are planted, it is absolutely impossible to cut out and repair musk-rat holes or washouts, owing to the millions of roots woven and interwoven throughout the bank.

The Closing of Breaches.—A breach usually occurs in the weakest place in the bank, viz., where there is little good material to be had and the bank is small, or where the material of which the bank is made is thoroughly unfitted for use, and these very conditions operate seriously against the stopping of them. The difficulty can be easily conceived when two hundred acres, more or less, are alternately covered with water and drained each change of tide. This water flowing through the breach produces a terrific current, which does not often wear the breach wide, but quite deep (usually to within five feet of the depth of the river-bed or to hard bottom).

These breaches must practically be stopped on one tide. Usually work is started just before low water, and the endeavor is made to keep the bank above the tide as it rises. If the tide once gets over the bank, the whole of your mud is carried in on the meadow, your work is thrown away, and, as a rule, the breach is in worse condition than before. Again, you have wasted all the material put into it, and there usually being a scarcity, this is the most serious loss. Much more material is required in a breach than on an ordinary bank, because the "green" mud must stand, on one tide, the whole pressure of the water.

Very few breaches can be closed by a dredging machine alone. Several methods are in vogue at present, and experience alone can dictate the place in which any one system can be successfully used. In many breaches several methods or a combination are tried before success rewards the work. The four methods mostly used are:

(1) Sand-bags; (2) stone; (3) sheet piling; (4) the use of wrecks.

1. This method is usually very successful. The bags weighing from five to six hundred pounds each when filled, it is difficult for even the strongest tide to move them from place, and the sand, being confined, cannot wash away piecemeal. The bags are piled as nearly as possible in layers, alternating in direction. When the breach is once stopped, these bags are thoroughly covered with dredged material to avoid any possible escape of the material when the bags decay.

2. Stone is very successfully used in smaller breaches, and has the advantage of being quickly and easily handled. Two good-sized parallel walls are built and dredged material deposited between the two, the object of the stone being to keep the mud from slipping out at the bottom when weight is placed above. This is not successful in large breaches, and on several occasions, upon looking for an unfinished wall of stone after the worst of a tide was past, nothing has been found, the stone having been picked up by the tide and distributed over the meadow.

3. Pile work is least efficient of any method, and can be used to advantage only on the smallest breaches. Sand-bags and stone start at the bottom and build up, keeping about the same elevation across the breach; pile work starts at one end and gradually narrows the breach, and, the same volume of water trying to get through a small space, the end piles are undermined, the wood construction goes out, and the breach is deeper than before. Sometimes the water simply eats its way under the construction, deepening the breach and washing out the pile work. These modes of failure are absolutely impossible with the first two methods, while the third method rather courts than avoids them.

4. At times an old canal-boat or lighter is sunk in the breach. This is a very effective way of stopping it, as the lighter when filled with mud does not easily move from one place to another, nor does the mud wash out, being confined in a strong wooden structure like a cofferdam.

At times breaches become of such dimensions that it is an almost hopeless task to start with one of the above methods. It often occurs that the deepest water is not on a line with the original bank, but inside of it, caused usually by use of material in efforts to stop the break by horseshoeing and progressively moving the material further back on the meadow (Fig. 5). The sketch shows a breach at first of rather small dimensions, becoming progressively larger and deeper owing to mishandling. In such a case the heaviest material available is put in scows, towed to the site of the work, and dumped in and around the break both in the meadow and the creek outside the line of bank. The endeavor is thus made to form a new bottom of hard material (coarse gravel is the best, sand being worthless); when this is accomplished, one of the above methods is resorted to and the breach closed.

It is rare that attempts at any of these four meth-

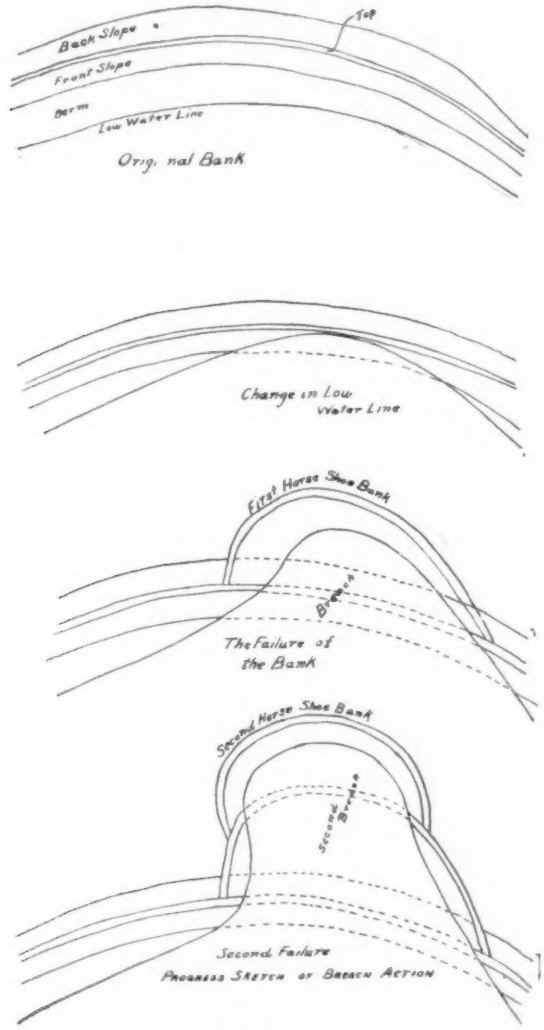


FIG. 5.

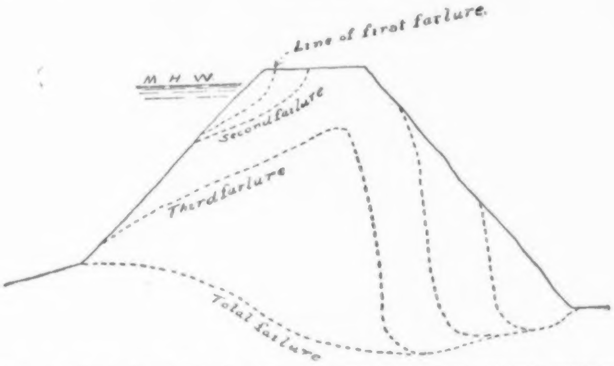


FIG. 6.—THE WEARING OF A BANK DUE TO HIGH TIDES.

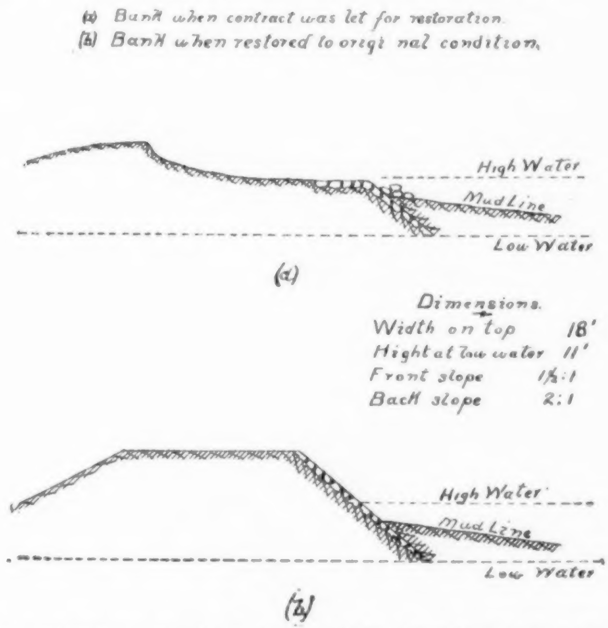


FIG. 8.—CROSS SECTIONS OF A BANK AT FORT MIFFLIN, PA.

ods are made on a line with the original bank, but horseshoes are made, the inside bank going in far enough to avoid the rush of water through the breach. This is the surest and cheapest way; but when the water is shut off, the original bank should be restored and the horseshoe bank not depended upon. Unfortunately, this is very rarely done, the bank managers usually resting on their laurels as soon as the water is shut off; the result is that the next time the bank fails you have to go further back into the meadow, thus cutting off more acreage as well as making a greater length of bank to care for. One breach near Philadelphia has seven horseshoe banks built, one behind the other; I might add, the breach is not stopped yet. The only way possible to stop this breach is to furnish, from an outside source, the material to fill the hole made by successive attempts to stop the breach. This material could easily be scowed in, and on the bottom thus formed the breach could be stopped by one of the methods above mentioned.

Failure.—If the face of a bank is kept in good condition and there is an ample slope on the back, failure rarely or never occurs. The musk-rat holes should be dug out at least once a year and the holes packed with green mud. The face of a bank yields to the wearing action of the tides at about high-water mark, or a little below, a hollow being formed, and the earth above falls of its own weight, thus lessening the width on top (Fig. 6). The greatest wearing action, arising from the water flowing over the top of the bank, occurs in the back, and causes serious damage only when the back slope is very sharp; then the fall of the water washes away the bottom of the slope and wears the bank through very rapidly.

The tendency of a musk-rat hole is to loosen the material in the bank, and it is a well-known fact that the places where these holes abound wash first.

Selecting the Site of a Bank.—Naturally, in selecting a site the landowner wishes as much land inclosed as possible, and the engineer conforms as nearly as is practicable to this idea. Again, nearly every farmer wants a "straight bank," i. e., the same distance back from the creek throughout the entire length. This is a mistaken idea. A bank is built not only with the idea of shutting off the water, thus permitting the cultivation of the land, but the kind of a bank should be built to insure future cheapness in maintenance; such a site should be selected as will insure the future stability of the bank (Fig. 7).

A creek or river bends in and out, and along the same creek many different forms of bank and protection should rightly be used. In the straight reaches the bank should be about fifteen feet back from the low-water line, and will probably need no artificial protection. This applies equally well to the bank on the convex side of the creek. On the concave side, where the tide runs close under the bank, some marsh should be left; then the dredged cut made; then fifteen feet of marsh, and, finally, the bank. This leaves enough berm to protect the bank from any immediate wear. The ends of the dredged cut should be shut off when the bank is completed, in order to prevent the tide from flowing through the cut, and thus endangering the bank. In the straight reaches and on the concave side of turns the dredged cut fills very rapidly, a cut of five feet depth being practically obliterated in the course of five years. Even the distance of the bank back from the creek above mentioned does not necessarily insure the bank's safety, and usually some protection must be added.

Materials of Construction.—Before leaving this subject it will be well to say a word as to the efficiency of various materials for bank building. As a rule in creeks the materials available are mud, clay, sand, and gravel, and the material used usually depends upon that nearest the site of the work.

Mud: Good clean marsh mud is by far the best material of which to construct banks. It packs well, is comparatively easy to handle, gets a sod quickly, and, when dry, does not powder, but forms a well-cemented mass. It is also the lowest material in point of cost.

Clay: Clay is of some value for puddling, forming a most impenetrable mass, but is also subject to the washing effect of rains and tide. Used with mud as a protection, it forms a valuable adjunct; but alone, is of little value. The cost is also prohibitive in many cases, it costing three times as much to handle clay as mud.

Sand: Sand is of value when confined (in bags, as explained above); but alone, is the worst of materials. It washes rapidly, never forms a compact mass, and I have known pretty good-sized banks to literally blow away when the sand becomes dried out.

Gravel: Gravel is a fair material when dry; but when wet is hard to handle. A small quantity of it getting into the bucket at one time there is room for a large amount of water, and the gravel, when released, is immediately washed to the bottom of the bank. This is a serious drawback from the contractor's point of view, and about doubles the price of the work. Another objection is the weight, since it is possible to place only about half as much gravel as mud on a bank.

The objection to mud is the waste of material. From careful calculations made a few years ago a conclusion was reached that the difference between bucket measurement and the mud in place on the bank, after drying, was fully 50 per cent.

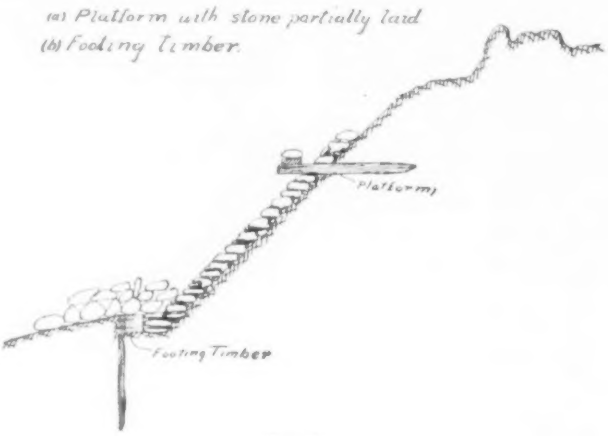


FIG. 9.

HAND-LAID DRY STONE PROTECTION.

When there is a stretch of protecting marsh in front of the site of the bank, mud revetments without protection will answer, and are much cheaper; but where they are subject to the wearing action of the tides or to the wave action produced by heavy wind, they wash rapidly, and are alone of very little permanent value. This is sometimes partially prevented by laying stone on the face of the bank, which prevents washing for a time, but eventually the earth backing washes from behind the stone, the stone falling into the hole thus formed, and that above comes tumbling down to the bottom of the bank, leaving it without protection (Fig. 8).

Construction.—There is quite an art in laying stone successfully, and it is difficult to get men who can satisfactorily perform the work. After a part of the mud is in place, usually a little above high water, the bank is shaped with shovels, being packed hard on the face. Nothing but carefully selected mud should be used and no pains spared to obtain it. Sand is worse than useless, and mud with even a small percentage of sand makes a poor backing for the stone.

Before the material is dry and hard the stone is laid. Often a log or square timber is placed about twelve inches in advance of the toe of the bank and the first course of stone laid inside of it (Fig. 9); this prevents the sliding out of the stone at the bottom. Lines are placed, to which the stone is to be laid, the stone being placed with the greatest width in a horizontal position. The lines should be so arranged that the stones, to reach the proper slope, must be pressed two or three inches into the backing.

A course of stone is laid, then all the interstices are carefully filled with chips of stone ("spalls"). This is a most important detail, and should never be neglected, it being best to drive these chips in hard with stone hammers to insure good contact. The next course is then laid and the operation repeated.

The stone is usually piled in front of the bank, the lower courses being laid at low water. There should always be two sections of the bank under construction at once: one which will put the mason above high water when high water comes; the other to permit him to avail himself of low water in placing his bottom courses.

Two men work together—a mason, who lays the stone, and a helper, who selects and passes the stone up to him from the pile below. On the high tide the helper is often up to his waist in water.

Little wooden platforms are erected at various heights on the face of the bank, and are used to store stone and also for the masons to stand upon while laying the upper courses (Fig. 9). These are not removed until the work is completed, and then the holes left in the wall are carefully filled with stone.

The usually accepted slope for these walls is 1 to 1. It has been found that at this slope the stone is neither displaced by tidal action, nor does it tend, by its own weight, to bury itself into the mud backing.

Heavy Dry Wall.—At times a heavier "dry wall" is laid, of several thicknesses of stone, and on a variety of foundations, but always with the same result eventually, namely, the washing of material from behind the wall and the falling of the wall itself.

These walls are five or six feet on the bottom with a width of about two feet on top, and are sometimes laid with a batter on the front, although usually built straight. They are really a waste of material, being very little better than a single layer of stone, and using probably more stone than a wall laid in cement. The best of these are put on a light, three-pile foundation, with flooring under the wall only and without sheeting.

(To be continued.)

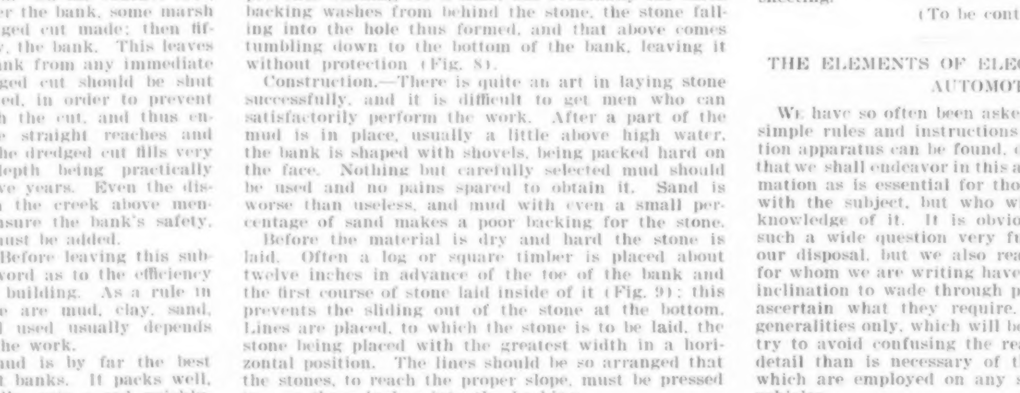


FIG. 7.

THE ELEMENTS OF ELECTRIC IGNITION FOR AUTOMOTORS.

WE have so often been asked either to specify where simple rules and instructions concerning electric ignition apparatus can be found, or to give these ourselves, that we shall endeavor in this article to afford such information as is essential for those who are unacquainted with the subject, but who wish to acquire a general knowledge of it. It is obviously impossible to treat such a wide question very fully within the limits at our disposal, but we also realize that many of those for whom we are writing have neither the time nor the inclination to wade through pages of print in order to ascertain what they require. It is generalities, and generalities only, which will be dealt with, and we shall try to avoid confusing the reader by going into more detail than is necessary of the precise arrangements which are employed on any specific types of existing vehicles.

Before starting, however, we should like to impress upon beginners that much time and trouble will be saved if they will make themselves at home with the principles involved, instead of trying to take a short cut by merely adopting a rule-of-thumb system, based on a practical knowledge of some particular machine. When once the functions of each part, and the manner in which they work, are clearly understood, the application of this knowledge to practice is easy, and is simply a question of common sense.

Although there are two fundamentally different methods at present used for producing an electric spark inside the combustion chamber of an engine, we only propose to deal with the system which is more generally employed in this country. The two systems

are generally known as the "high tension" and the "low tension," but are sometimes also termed the "jump spark" and the "wipe spark." The former is that with which we are now concerned; the latter is more common in America, although it is also employed in some British and on a few Continental automobiles.

In order to still further clear the ground, it may be said that either of these main systems is divisible into two groups, but that here again we shall neglect the less usual. We refer to the substitution of a mechanical generator of electricity for a battery, but as this substitution is all that is implied by "magneto ignition" we need not, in this article, more than mention its alternative application for either system.

In the first place, let us state a few of the chief elementary axioms which must be grasped before further progress is possible: (1) An electric current will only flow through any conductor provided that its ends are in metallic connection (either direct or through the intervention of other conductors) with *both* terminals of the battery, or other source of electricity. (2) Conversely, an electric current will flow through any and every such "closed" metallic circuit, however many there may be. (3) The amount of current which flows through a circuit depends upon the absence of resistance in its path.

It follows from these three axioms: (1) That a complete circuit must be made from one pole of the battery to whatever apparatus requires the current, and that a return conductor must lead back again to the other pole of the battery before any current will flow from the battery; (2) that great care must always be taken to see that there is no other metallic path, or closed circuit, than that (or those) actually required; and (3) that every precaution should be taken to insure clean metallic faces and tight joints wherever conductors are connected together.

The various parts of the apparatus required for electric ignition, of the high-tension kind, as also their respective duties, are as follows: (1) *The battery*, or source of electric current. (2) *The induction coil*, or transformer of the low-tension current (given by the battery) into high-tension current. (3) *The contact breaker* (sometimes called the trembler), which causes the steady flow of current from the battery to be broken up into intermittent waves. (4) *The condenser* (which some amateur automobilists do not seem to know the existence of) which intensifies the intermittent waves and also reduces the sparking at the contact breaker. (5) *The ignition plug*, or air gap in the circuit of the high-tension current.

Taking each of these parts separately, let us briefly review their characteristic features: *The battery* is composed of two, three, or four cells, each of which is a complete source of electricity in itself and has a positive and a negative pole. These cells are made in different ways, of different materials, and in various sizes. The reason why more than one is employed is that their "voltage," or electrical pressure, is limited, and that it is insufficient to force the necessary amount of current through the other apparatus employed. This "voltage" varies with different forms of cell, and hence the number required varies. In order to obtain sufficient "voltage" the separate cells are connected together in "series," i. e., the current from all is caused to flow in the same direction through the same circuit, and all the current flows through all the cells. To arrange this the positive of the one cell is joined to the negative of the next, and so on, so that there is one free negative terminal (on the first cell), and only one free positive terminal (on the last cell). The resulting "voltage" across these end terminals will then be the sum of the "voltage" of all. The rate at which current will flow through any given circuit depends almost entirely upon the "voltage" of the battery, and not so much on the size of the cells. The *time* during which the battery will continue to supply current at any given rate is what is chiefly affected by the *size* of the cells. We do not propose to go into the question of the construction of batteries, and need only add that care must be taken to see that there is no other path for the passage of current between cell and cell than that afforded by the connections above mentioned.

The *induction coil* consists of an iron core, around which is wound a coil of insulated copper wire. A second coil of much finer insulated wire is wound outside the other coil. Such is the entirely mechanical construction of an induction coil pure and simple. The inner and outer coils are carefully insulated from one another, and there should be no metallic or conducting connection between them at all. The only connection which there is is a magnetic one. The action of this apparatus is as follows: When a current from a battery is sent through the inner coil of wire, it magnetizes the iron core, and when the current is switched off the iron core loses its magnetism. A further effect which is produced by alternately "making" and "breaking" the circuit from the battery through the inner coil is that a high-tension current is "generated" in the outer (fine wire) coil. It may here be stated that a current of electricity, such as that given by a battery, is unable to jump across even the smallest air-space between one conductor and another, but that a high-tension current, such as is generated in the outer coil of an induction coil, is capable of jumping a certain distance across from one point to another, provided that it will complete the electrical circuit from one pole to the other by so doing. Without going into greater detail on the point of induction-coil construction, we would add that, simple as this apparatus may appear from our brief description of it, it is by no means one of those things which can be made advantageously by anyone.

The *contact breaker* is a device for alternately "making" and "breaking" the flow of current from the battery to the inner, or "primary," coil of the induction coil. It consists of a flat spring, held at one end, which can be brought into contact with, or removed from, a fixed metallic contact. Wires are connected both to the spring and to the stationary contact piece, and the effect of the device is to join these together electrically, and alternately to sever such a connection between them. The contact breaker is, in most induction coils, made a part of that apparatus, and the actual working of it is automatically effected by the magnetic pull of the iron core, in the same manner that an electric bell works. In some cases such an arrangement is retained on coils used for automotors, but in the majority of cases the contact breaker is actuated by a cam on the motor. In the former case a cam on the engine merely switches on the current to the automatic coil, when a spark is required in the engine. The latter arrangement, however, is generally used for high-speed motors so as to secure as positive and instantaneous an action as possible. The actual contact points of this device are generally made of platinum, in order both to avoid any burning away of their surfaces by the sparks which pass between them, and because platinum keeps comparatively clean.

The *condenser* consists of two sheets of tinfoil, which are carefully insulated from each other by an intermediate sheet of paraffined paper. In practice a number of sheets of tinfoil are used, but, as all alternate sheets are connected together, this arrangement comes to the same thing. One of these sheets of tinfoil is connected by a wire to the vibrating spring of the contact breaker, and the other sheet is similarly connected to the fixed contact piece of the device. The precise action of the condenser need not be gone into in any detail for the purposes of this article; suffice it to say that, when in use, it absorbs part of the electrical energy which would otherwise be wasted in useless and harmful sparking at the contact breaker and that it returns this energy to the induction coil in such a manner as to increase the high-tension current generated there. It may, however, be useful to point out that no current from a battery can flow through a condenser—i. e., there is no conducting circuit through it.

The *ignition plug* consists of an outer case which passes through the wall of the combustion chamber. This case incloses a central metallic wire, which is carefully insulated from it by a greater thickness of porcelain, or other insulation, than can be jumped across by the high-tension current employed. The inner wire and the outer case are respectively joined to the two terminals of the outer, or "secondary," coil of the induction coil, and a wire joined to the case is brought within easy sparking distance of the central wire. The distance across this spark gap must be less than what would be required outside the engine, because the resistance of a compressed explosive mixture is greater than that of air at atmospheric pressure.

The electrical connections between these various parts should be as follows: One wire (*a*)* from the one battery terminal should pass direct to one end of the inner (primary) coil of the induction coil. The other end of this coil should be connected (*b*) to one terminal of the contact breaker. From the other contact piece of this device, a wire (*c*) should pass back to the other terminal of the battery. It is immaterial, as a rule, which terminals of any part should be connected to the next part, but in certain cases leakages may be reduced or rendered less detrimental by changing over the wires. We have already stated that the condenser must be connected across the terminals of the contact breaker; it is for this purpose the wire (*c*) passing from the contact breaker direct to the battery, is taken back to the induction coil, in the base of which the condenser is usually placed. The only other connections which are necessary are a wire (*d*) (most carefully insulated), from the outer (secondary) coil of the induction to the central conductor of the ignition plug, and a connection (*e*) from the other end of this coil to the outer case of the plug. It is usual in practice to utilize the machinery itself as part of the latter conductor (called "earth"), and it is essential in most cases that the former wire (*d*) should be connected to that end of the "secondary" coil which comes from the last wound layer. An ordinary switch of any kind should be inserted in either of the wires (*a* or *c*) leading from the battery.

The action of the apparatus will now have been realized. When the contact breaker is actuated, a current flows in waves from the battery through the primary winding of the induction coil, through the contact breaker itself, and back to the battery. A high-tension current is then generated in the secondary winding of the induction coil, and this current passes through the ignition plug, across the spark points, and back to the induction coil.

Bearing in mind the foregoing remarks, it is obvious that there are several important points which require special attention, but that it would be impossible here to even touch upon them all. Mention, however, should be made of those following: The ignition plug should be inspected occasionally, the porcelain seen to be tight and clean, and the distance between the spark points noticed. The contact breaker should be most carefully adjusted, and should be kept as clean as possible. Care should be taken to keep all oil from getting upon the insulation of any of the apparatus or wires. The switch, which completely breaks the battery circuit at any time, should always be turned off while the motor is at rest; there is otherwise a chance that the contact breaker may be "on," and that the battery will be run down in consequence—it should here be pointed out that the amount of current which the induction coil can take from the battery when the contact breaker is *left* "on" is greatly in excess of that normally taken by it.

It may now be useful to give some instructions by which anyone can ascertain which terminals are which, upon the more usual induction coils now in use. In some cases these are not marked clearly or at all, while in many cases single letters, which are of little assistance unless one knows what they mean, are placed against the different terminals. Induction coils having condensers *and* contact breakers combined as one apparatus are generally fitted with four terminals only, and there can scarcely ever be much doubt as to which are the primary and which are the secondary. However, it is only necessary to take a wire from each pole of a battery, and to touch them against alternative terminals; the contact breaker will vibrate when these wires are making the right connections. Induction coils, without contact breakers, may have six different terminals—two for receiving the battery wires, two for wires from the contact breaker, and two for the high-tension circuit, but more often there are only five, because one of the battery wires and one of those from the contact breaker are to be joined together in any case, and may therefore be brought to the one (condenser) terminal. Assuming that there are six of these unknown terminals, the *modus operandi* may be this: Touch the two wires from a battery on to different terminals (one wire to one terminal) until a spark is seen when drawing one of the wires away; this spark will be larger if the wire makes contact for a few seconds than if only for a moment, provided that the correct terminals (*a* and *b*) have been found. There will then be two other terminals (*c* and *d*) (those for the high-tension circuit), connected across which an ignition plug will spark whenever the first operation is repeated. When these four terminals (*a*, *b*, *c* and *d*) have thus been discovered, two of them (*c* and *d*) will be known to be the high-tension connections, and it will also be known that *one* of the others (*a* or *b*) is a battery terminal, and the other (*b* or *a*) is a contact-breaker terminal. The next operation is to connect the remaining two (where only five in all, there will be only one) terminals (*e* and *f*) together; in some cases these are already connected inside the box, and it is for this reason that during the first operation an *ordinary* battery spark might be seen when testing them. One contact-breaker wire *and* one battery wire will ultimately be connected to these (or this) terminals (*e* and *f*). It only now remains to find out which of the two original terminals (*a* and *b*) is for the other battery wire, and which for the second wire from the contact breaker. First connect one battery wire to its known terminal (*e*) and place an ignition plug in circuit across its proper terminals (*c* and *d*). Then connect the other battery wire first to one and then to the other of the two unknown terminals (*a* and *b*). While this wire is on one of them (*a* or *b*) make and break connection between the known battery terminal (*e*) and the other of them (*b* or *a*); and while the wire is on the other (*b* or *a*) do the same thing to the first one (*a* or *b*). In the one case a larger spark will jump across the ignition plug, but a smaller low-tension spark will appear at the "break" wire; the second battery wire will then be known to be in its correct terminal, and all the terminals will now be known.

Much could be written on the subject of testing for faults when they appear, but we must content ourselves at the moment with only a few general remarks upon it. This testing is decidedly an art, in the exercise of which much patience, combined with sound common sense, is sometimes essential, if time be any object. Assuming a case in which the ignition device is evidently failing to act, and in which there have been no special symptoms which would lead one to take an abnormal course of action, the following diagnosis may be found useful: Ascertain whether a spark is produced by touching a conductor across the contact-breaker terminals; if so, it is probable that the low-tension circuit is all right; but if not, it will be necessary to take further steps in this direction. Assuming that this spark was produced, either remove the ignition plug and examine it, or first withdraw the insulated wire from it and connect this to a spare plug outside the cylinder. By making and breaking the primary circuit, it will be easy to determine whether the plug is at fault or not. If now the ignition plug is found to have been in proper order, it will be advisable to see that the contact breaker is working properly. In cases where the low-tension circuit is defective, it is wise to ascertain, in the first place, that all terminals are tightly screwed down. Failing to find the trouble, we should then place the contact breaker at its "on" position and take a trial wire with which to complete each in turn of the proper connections between battery, coil, and contact breaker, in order to discover any broken wire. If either of these permanent conductors had broken, a spark would be seen as soon as our trial wire had temporarily replaced it. Gradual elimination of possible causes can alone lead to any certain discovery, and complete knowledge of the apparatus employed is the only essential qualification required.

It is true that cases may arise in which it is extremely difficult to locate a fault. Among these there are few worse than where everything is apparently in perfect order when the machine is at rest, but in which its vibration causes the displacement of some important part so soon as a fresh start is attempted.

Here, however, we must leave an important and engrossing subject, and shall conclude by pointing out a chance of electrical breakdown, which is only rendered possible by the almost universal practice of allowing an "earthed" cam to operate direct upon a conducting contact-breaker spring; since one of the "secondary" wires is also "earthed," it follows that there is a high-tension difference of potential between the whole primary circuit and the insulated "secondary" wire; this arrangement also means that the primary circuit is otherwise unnecessarily "earthed," and that the chances of its insulation breaking down are enormously increased.—The Automotor Journal.

* The letters in brackets are only used in order to render any possible ambiguity impossible.

ELECTRON THEORY OF LIGHT.—W. Voigt has made the attempt to formulate an electron theory of the changes in the optical properties of ponderable bodies produced by mechanical and thermal deformation. The electron theory asumes the existence within ponderable bodies of corpuscles oscillating about approximately fixed positions. But both the quasi-elastic force which drives the particle back to its mean position and the resistance it experiences in its vibrations or revolutions hitherto lacked electrodynamic explanation. The author shows, however, that the quasi-elastic forces decrease when a liquid undergoes compression, so that the stability of the oscillatory electrons is lessened. A rise of temperature under constant pressure leads, on the other hand, to an increase of the quais-elastic force and of the stability. In solids the exact reverse is the case. The author explains how in gases and liquids compression produces a displacement of the spectrum lines toward the red, owing to the decrease of the quasi-elastic forces, and investigates in detail the effect produced by adding the same solute to different solvents.—W. Voigt, Ann. der Physik, No. 11, 1901.

MECHANICAL SHIPMENT OF COAL.

FOR the shipment of the coal of the Marles mines, there has recently been applied at Bethune an extremely simple process, which has the advantage of economizing time and money, and that, too, with hardly any expenditure of motive power.

The Marles Coal Mining Company has constructed a wharf upon the canal, at Bethune, in order that it may deliver its products by water. The coal reaches the wharf in cars running upon ordinary tracks. In order to avoid a useless output of motive power, recourse is had simply to gravity, which has the advantage of being attended with no expense. The trains reach the upper quay, which is constructed at a sufficient height above water to allow the cars to dump the coal into lighters.

In order to permit of easy operation and to assure a proper efficiency, it was necessary to have an automatic oscillating device that should permit of performing the operations very rapidly. The problem was very well solved by MM. Taza and Villain in an altogether practical arrangement that was shown at the last Exposition.

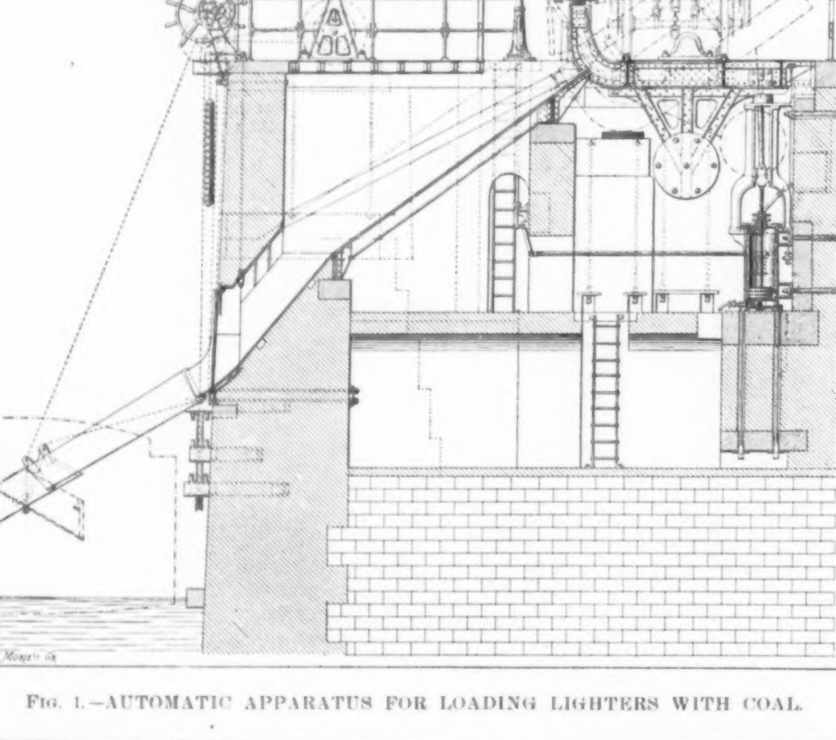


FIG. 1.—AUTOMATIC APPARATUS FOR LOADING LIGHTERS WITH COAL.

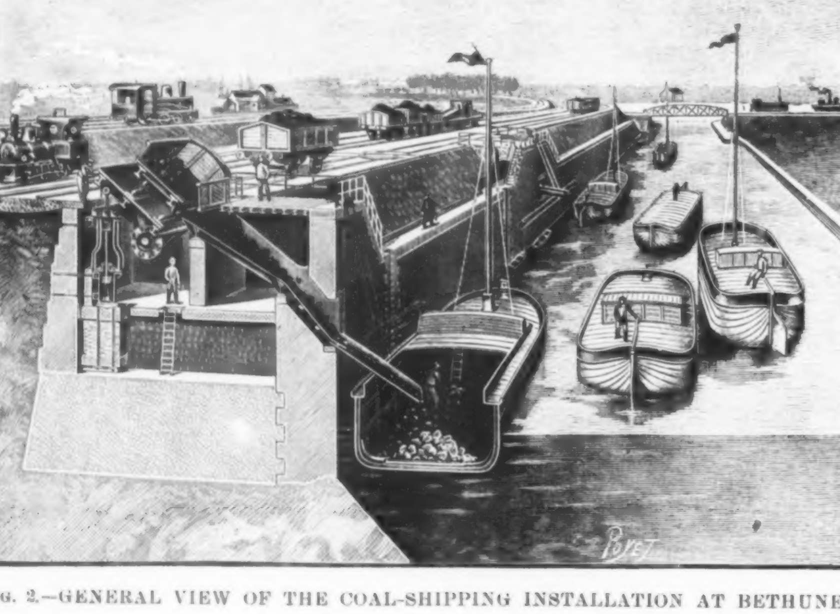


FIG. 2.—GENERAL VIEW OF THE COAL-SHIPPING INSTALLATION AT BETHUNE.

The apparatus consists in principle of a metal platform that carries a track of normal gage, and upon which stops the car loaded with coal. A slight motion communicated to the system effects the tilting of it, and the coal runs through a hopper into a chute that leads it to the hold of the boat. The platform then automatically resumes its primitive position and the car is shunted to a side track in order to give place to another one.

In theory, this operation seems very easy, but in practice it was found to be quite difficult, because of the precautions that it was necessary to take, in the first place to prevent shocks and in the second to permit of the automatic return of the platform to its initial position after the unloading.

For this reason the apparatus was provided with two special devices: a hydraulic brake and a differential pendulum.

The brake consists of a cast iron cylinder 16 inches in diameter installed in a cavity formed in the wall of the quay, and in which moves a piston, the rod of which is operatively connected with the platform. The two faces of the piston are in contact, in the cylinder, with water under pressure furnished by a special piping. When the platform tilts in order to dump the coal from the car, the piston compresses the water situated above it, and there supervenes a resistant stress that prevents the apparatus from tilting with violence and occasioning disorder. As it might happen that the water, on account of being compressed, might prove an obstacle to the motion of the apparatus and bring it to a standstill in the middle of its travel, the system is provided with cocks that permit of regulating the pressure in the two chambers of the cylinder, so as to obtain as gentle a motion as possible during the tilting.

The righting of the platform is produced by the differential pendulum. The car, provided with its 10-ton load of coal, is shoved upon the platform, which swings upon two strong journals about three-quarters of an inch in diameter, placed outside of its axis, so that, through the simple weight alone, the entire system has a tendency to incline to the side toward the canal. The pendulum consists of two counterpoises fixed by rods to the under side of the platform. They weigh 11,000 pounds, which is a weight greater than that of the empty car, so that, as soon as the dumping has been effected, that is to say, when the weight of the coal no longer acts, the platform and its contents are pulled back by the pendulums. These latter have a negative role during the first part of the operation, but become active during the second.

A peculiar arrangement is introduced into the cars, which are so constructed that the side shall be movable around the upper edge. The jointed face forms a sort of trap, which may be opened at the moment desired by acting upon a lever arranged for the purpose. When the apparatus tilts, the weight of the coal bears against the side of the car and gives it a tendency to open, and this greatly facilitates the motion of the operating lever. The entire load of 10 tons falls at once into the hopper, which is large enough to contain it, and which is directly connected with a distributing chute that may be moved at will so as to produce a uniform load in the hold of the lighter. The time that it takes to dump the coal is sufficient to permit of the return of the swinging platform and the putting in place of a full car.

Against the quay wall there has been installed a system of towing by means of cables winding around drums. This arrangement has been made with a view to the quick shifting of a lighter as soon as it has been loaded, and to the replacing of it by another. One man, by the aid of these windlasses, is able to move the boat. On the other hand, the arrangement of this process of towing upon the wall of the quay takes up but little room, and in nowise interferes with the handling of the cars upon the upper bank.

There are two of these platforms at the port of Bethune. With well drilled gangs of men, it is possible to unload 25 cars, say 250 tons of coal, an hour, that is to say, 5,000 tons a day of ten hours, with both apparatus. These figures alone suffice to show what great services such apparatus are capable of rendering in the exploitation of mines.—For the above particulars and the engravings we are indebted to La Nature.

WEIGHT AND CAPACITY OF LOCOMOTIVES WITH VANDERBILT BOILERS AND TENDERS.

THERE has been some unwritten discussion about the weight and capacity of locomotives having Vanderbilt boilers and tenders, compared with weight and capacity of locomotives as commonly designed. It has been said that the cylindrical designs impose greater weight for a given capacity, in both engine and tender.

Among numerous references to the Vanderbilt designs published in the Railroad Gazette some examples might be found that would tend to strengthen the foregoing opinion, but a conclusion thus drawn would be wrong when all the conditions thus far met in using these designs are considered. For example, a comparison of the standard New York Central mogul No. 1,753 with the New York Central Vanderbilt mogul No. 1,766 shows that, while the total weight of the Vanderbilt locomotive is greater than that of the standard locomotive, the total weight of engine per square foot of heating surface is less for the Vanderbilt locomotive than for the standard. Some of the engines have been prepared for and sent into the most trying "hard water" districts, and there has been only one tender built.

It is at once apparent that an exact comparison is hard to make. To emphasize this it may be said that in tenders of general rectangular form with water legs extending forward, the dead weight and equal carrying capacity varies as much as 1,500 pounds, according to the ideas of the designer, and proportionately greater variations may be found in locomotives of approximately equal steaming and tractive capacity.

The first Vanderbilt tender, for Illinois Central engine No. 64, illustrated in the Railroad Gazette, May 31, page 366, weighs practically the same as an Illinois Central tender of ordinary design for the same duty. The Illinois Central engine is somewhat heavier than other engines of the same class, but has more heating surface. Reference to the illustrations and descriptions shows that while advantage was taken of experience in determining the weight of the engine, this first tender, in order to leave no question of durability, was made heavier in several respects than seemed really necessary. This applies to the thickness of the shell and to some of its reinforcements as well as to some of the framework of the tender. Experience has shown that some of these parts can safely be reduced in weight, that the general principle of building is correct and that the first estimate of a possible 15 per cent saving in dead weight is reasonable, when the ordinary and the Vanderbilt tenders are both built as light as is consistent with strength. This has been fully established in designing the tender of the locomotive for the Plant System, to which we recently referred.

Of engines it may safely be said that for equal steaming capacity the Vanderbilt design need not be made heavier and may be made lighter than the ordinary design. This was shown in building the Buffalo, Rochester & Pittsburg consolidation engine No. 250, which was illustrated and described in our issue of September 13, page 631. We have compared drawings of that engine with those of an engine built as nearly as possible like it and of equal cylinder power, but having sloping grates in an ordinary wide firebox above the frames. The weights, heating surface and cylinder dimensions of both engines are given herewith:

COMPARISON OF TYPES.

	Vanderbilt engine.	Wide firebox engine.
Cylinders	22 x 28 in.	22 x 28 in.
Heating surface, firebox	135 sq. ft.	169 sq. ft.
Heating surface, tubes	2,450 sq. ft.	2,424 sq. ft.
Heating surface, total	2,585 sq. ft.	2,593 sq. ft.
Grate area	33 sq. ft.	35 to 46.5 sq. ft.
Weight on engine truck	17,700 lbs.	20,400 lbs.
Weight on drivers	151,900 lbs.	154,270 lbs.
Weight, total	169,600 lbs.	174,670 lbs.
Difference, grate area		(more) 2 to 13.5 sq. ft.
Difference, heating surface		(more) 8 sq. ft.
Difference, total weight		(more) 5,070 lbs.

From this it may be noted that while the heating surface of the wide firebox engine exceeds that of the Vanderbilt engine by 8 square feet, the total weight of the wide firebox engine is about $2\frac{1}{2}$ tons greater than that of the Vanderbilt engine. The grate area, 46.5 square feet in the wide firebox engine, is 13.5 square feet greater than in the Vanderbilt engine, but engines the same in all other respects have been built with 35

square feet of grate area. The difference is, therefore, given as ranging from 2 to 13.5 square feet more in the wide firebox engine. From recent reports it is learned that the Buffalo, Rochester & Pittsburg engine is doing quite as well as was expected of it.

The amount of grate surface required or obtainable bears vitally on the steaming capacity. It is plain that the available room for grates in the cylindrical firebox is less than that in the rectangular firebox when the diameter of the cylindrical firebox is not greater than the width of the rectangular box at the fire line. The same would be true in regard to heating surface in the firebox, within those restrictions, but thus far a circle 59 inches internal diameter has been taken as the size that can best be used and leave room to safely cover the crown with water, give enough steam room and grate area, and keep the grates at a suitable height. This diameter, it should be noted, does not represent a circle that could be inscribed in the average firebox width, but may be regarded as a compromise between such a diameter and the diameter of a circle within which the clear cross width of the average rectangular firebox could be inscribed as a square.

Since the general movement toward very wide fireboxes in the last three years there has been but slight effort to further increase the efficiency of moderately wide fireboxes. There are some exceptions to this rule, notable among which are some sub-divisions of the Class F moguls of the Pennsylvania Railroad, where a difference of more than 26 inches in width of the firebox, and some differences in depth, are found, the engines of the two classes, F-3 and F-3b, being otherwise the same. It is not hard to find those who believe that the wide firebox idea has been somewhat overdone in trying to provide for extreme conditions of service, at the expense of economy in average duty; in short, that some of the largest engines partake too much of the coke-oven principle, distilling large amounts of gas that flames for a moment and is quickly extinguished and lost in the tubes; also requiring too much coal when the engine is side-tracked.

The idea is that enough of anything is plenty and that this is especially true of grate area in locomotives. This comment, of course, applies chiefly to soft coal burning and in the same way it is suggested that it is just as well to consider first how little grate area may be used, how the gases may be kept flaming longest, and how firing may be easiest done, rather than how much grate area can be provided regardless of the secondary stages of combustion. Putting in a very large amount of grate with the intention of shutting off part of it with dead plates when the engine is assigned to less than maximum duty is not advisable. The dead-plate in a firebox, either at front or back, is troublesome and usually it may be depended upon for several kinds of trouble, including warping or breaking, collecting ashes and mixing them with half-burned coal, making smoke, and letting air into the firebox at the wrong time or place. It is a menace to the service because of its apparent simplicity and really great capacity for doing harm. Its simple appearance invites neglect and thus its worst extravagance is likely to be found in a heavy engine doing comparatively light work.

Our observation leads us to believe that when it is desirable to reduce grate area the best way is to remove any number of grates that can be spared nearest to the flue sheet; build a low bridge wall of fire brick on the last remaining grate at the front and disconnect that grate from the shaker bar if it is a rocking finger grate; then inclose a deep space between the bridge wall and the flue sheet, as a pocket for sparks. This gives the benefit of long flameway with no accumulation of ashes in the firebox proper. We have known an engine with 7 square feet of dead-plate to bank five rows of flues solid with ashes in less than 100 miles of freight work, and the same engine, without changing the draft apparatus, worked without clogging when the dead-plates were out. When the flame is given a clear space between the forward edge of the burning coal and the flue sheet, and swirling sparks are trapped before entering the tubes there is a double advantage. Practically smokeless firing is possible, and better results are obtained from the coal.

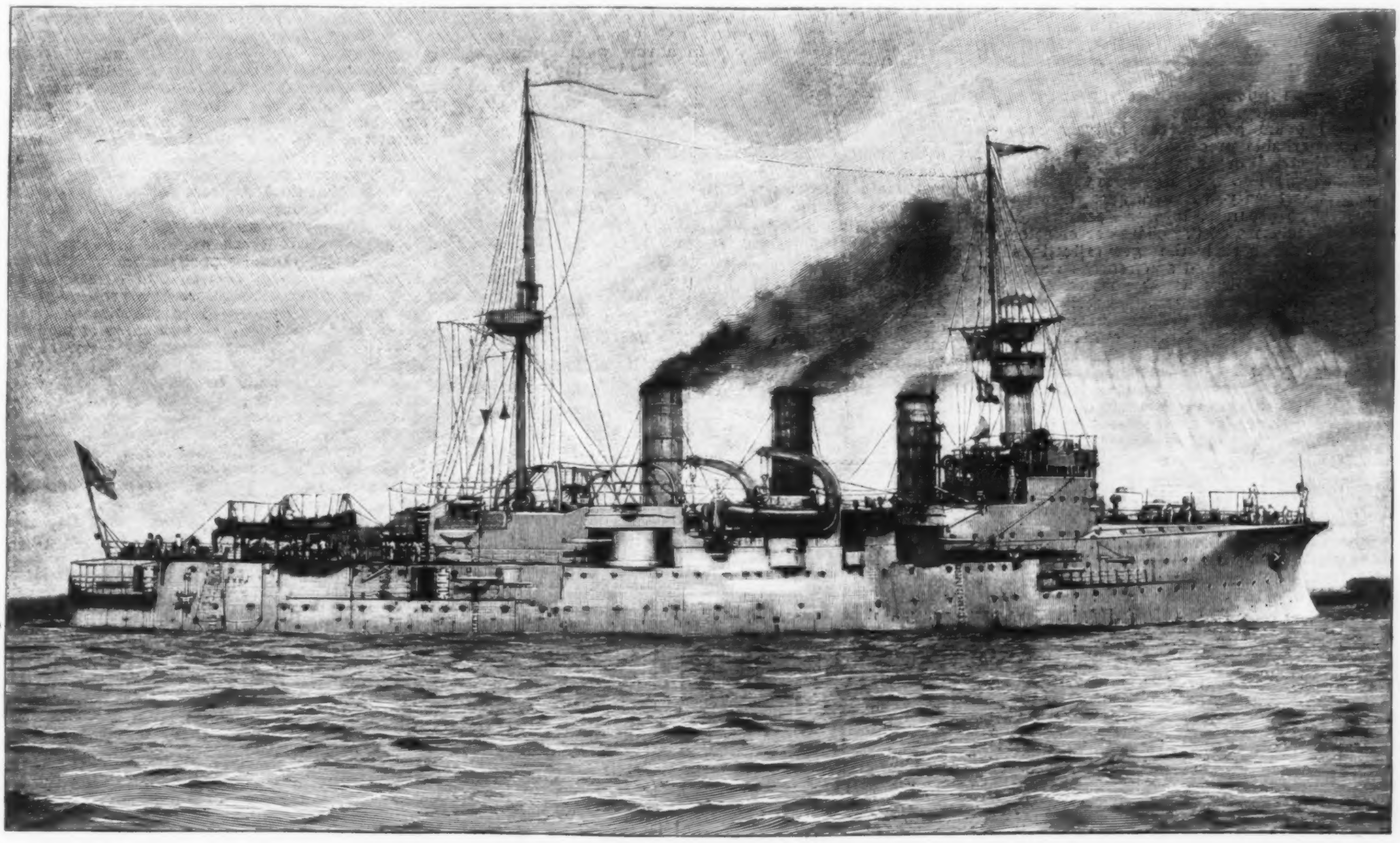
The idea we have outlined was successfully used in the Johnstone experiments on the Mexican Central Railway in 1892. Mr. Johnstone used a cast-iron hopper in front of and below a high brick arch stepped up from the front edge of the grates and supported on the side sheets. The Santa Fé tests (Railroad Gazette, June 16, 1899, page 423) included the use of such a hopper, but it was larger than the Johnstone hopper and had only a plain vertical bridge wall 20 inches high at the front edge of the grates. This gives a clear flameway of 3 feet from the coal to the flue sheet. The engine thus equipped worked about four months in heavy freight service before the simple pocket of ¾-inch boiler steel, with a plain side bottom, warped and burned out. In this case the total grate area was only 18.9 square feet, the engine was a four-cylinder tandem compound, equivalent to a 21x28-inch simple engine, and the fuel was soft coal, giving about 8 per cent ash by analysis and about 16 per cent ash by stationary boiler firing test. The boiler of this engine gave plenty of steam, even when the engine was working at full tractive force with 120 pounds graduated high pressure in the low-pressure cylinders and feedwater at 45 deg. F. was being fed at the rate of 2,800 gallons or more an hour. The evaporation was from 6 to somewhat over 7 pounds of water per pound of coal observed. This engine at first had 1,812 square feet of heating surface and 29.2 square feet of grate area, the ratio thus being about 62 to 1. The reduction of grate area to 18.9 square feet made the ratio about 95 to 1. The working speed was usually not above 35 miles an hour and the heaviest demand was at speeds ranging from 6 to 20 miles an hour.

The Vanderbilt boiler embodies the principle considered. The combustion chamber as a feature of locomotive boilers has been thoroughly discussed and its difficulties are well understood, but its greatest advantage, long and unobstructed flameway, can be had by setting apart the forward end of the firebox for this purpose as in the Vanderbilt boiler, or in some acceptable modification of the constructions we have previously mentioned. It would, therefore, seem that the general questions of grate area and pounds of coal burned per square foot of grate per hour, as applied to locomotives, largely resolve into the question of how used, rather than how much. Regarding the shape of firebox it is quite generally conceded, from D. K. Clark to the latest man who has discussed the question, that to get the best evaporation it is well to delay the contact of flame with firebox sheets as long as possible in the locomotive. Width for width, the cylindrical firebox does this to a greater extent than the rectangular firebox can.—The Railroad Gazette.

Colorless Waterproof Coating.—A colorless waterproof coating is obtained by a mixture of 1 part of tannin, 3 parts of turpentine and 4 parts of hot water well intermixed. The preparation is applied warm and, after the first coat has dried, a light coating of pure hot linseed oil is put on. When this is hard, the articles may be used.—Farben Zeitung.

THE GERMAN CRUISER "VINETA."

WE publish herewith an engraving (for which we are indebted to the Illustrirte Zeitung) of the German cruiser "Vineta," which is at present in South American waters. She is a sister ship of the "Hertha," and was launched in 1897; she has a displacement of 5,900 tons and a crew of 249 men. The recent slight misunderstanding between Germany and Venezuela grew out of an attack, first by police and afterward by a mob, made on two non-commissioned officers of the "Vineta" when on shore at Puerto Cabello. Since then the government has ordered two cruisers, the "Falke" and the "Gazelle," to join the "Vineta," so that the interests of German subjects which are endangered by the war between Colombia and Venezuela may be properly protected.



THE GERMAN CRUISER "VINETA."

FISH-CURING.

MOST people know in a general sort of way that herrings are migratory fishes, and that the shoals appear off the Hebrides and then travel in a southerly direction round the coast of Scotland and England. The date at which they first appear is not always exactly the same, but it does not differ to a much greater extent than that of the first appearance of the cuckoo in the south of England or the departure of the swallows from the eastern coasts. The shoals of herrings are followed by fleets of fishing-boats, some of which come from ports as far from the North Sea as Penzance in Cornwall and Brixham in Devonshire. The fishermen who man these boats are, however, not the only people whose movements depend on the migration of the herring. A great many women are similarly affected; they are to be numbered by thousands, and it is to the unnecessary hardships endured by these people that we wish to direct attention. The industry of fish-curing is performed in great part by a nomadic population consisting chiefly of strong and healthy young women, daughters of fisher folk, who go from the north toward the south and return home after their work is done. Some come from places as far north as Stornoway and Shetland. Fraserburgh and Peterhead are the centers of the fish-curing industry in July and August, Scarborough and Grimsby in September, and Yarmouth and Lowestoft in October. To give some idea of the number of people engaged in the work it may be said that as many as 3,445 women have been engaged at one time at Fraserburgh, and of these no fewer than 3,000 were "foreigners"—for among fishing people everyone not born in the place is a foreigner. The work which has to be done is cleaning, salting, and packing the fish for the continental markets. The sleeping accommodation provided for the women is not luxurious, but it is possibly better than many of them enjoy at home—and, according to an official report made by one of the factory inspectors, they live in a state of "marvelous harmony." In Yarmouth the curing trade is carried on in an open space which is undrained and the soil of which is therefore much polluted. Here the work is done in spite of wind and rain. The processes which precede the making of kippers—the pickling and splitting of the fish—are carried on under cover. The people engaged in the work are crowded, the rooms are often ill-lighted, the flooring is defective, and proper provision is not made for the removal of the refuse. This state of things is not one to be commended, and the sanitary authorities of Yarmouth cannot be held to be entirely free from blame in this matter, especially as the land on which the open-air work is carried on belongs to the town, and therefore the civic authorities are the more easily able to make proper restrictions as to its use. It is to

be hoped that in the future they will not neglect to carry out such an obvious duty. In France and in Belgium the factory laws insist that the walls and floors of rooms in which organic matter is treated shall be made of impermeable material, and, moreover, they provide for the immediate removal of organic refuse. It would be well if similar regulations existed in England. But in the absence of such a law there is the more reason why those who work at fish-curing should at least have the full measure of protection which is provided for them by the statutory provisions which are already in force in matters pertaining to the public health.—The Lancet.

PHYSIOLOGY.*

WHEN the British Association met in Glasgow twenty-five years ago I had the honor of presiding over Physiology, which was then only a sub-section of Section D. The progress of the science during the quarter of a century has been such as to entitle it to the dignity of a section of its own, and I feel it to be a great honor to be again put in charge of the subject. While twenty-five years form a considerable portion of the life of a man, from some points of view they constitute only a short period in the life of a science. But just as the growth of an organism does not always proceed at the same rate, so is it with the growth of a science. There are times when the application of new methods or the promulgation of a new theory causes rapid development, and there are other times when progress seems to be slow. But even in these quiet periods there may be steady progress in the accumulation of facts, and in the critical survey of old questions from newer points of view. So far as physiology is concerned, the last quarter of a century has been singularly fruitful, not merely in the gathering in of accurate data by scientific methods of research, but in the way of getting a deeper insight into many of the problems of life. Thus our knowledge of the phenomena of muscular contraction, of the changes in the secreting cell, of the interdependence of organs illustrated by what we now speak of as internal secretion, of the events that occur in the fecundated ovum and in the actively growing cell, of the remarkable processes connected with the activity of an electrical organ, and of the physiological anatomy of the central nervous organs, is very different from what it was twenty-five years ago. Our knowledge is now more accurate, it goes deeper into the subject, and it has more of the character of scientific truth. For a long period the generalizations of physiology were so vague, and apparently so much of the nature of more or less happy guesses, that our brethren the physicists and chemists scarcely admitted the subject into the circle of the sciences. Even now we are sometimes reproached with our inability to give a complete solution of physiological problems, such as, for example, what happens in a muscle when it contracts; and not long ago physiologists were taunted by the remark that the average duration of a physiological theory was about three years. But this view of the matter can only be entertained by those who know very little about the science. They do not form a just conception of the difficulties that surround all physiological investigation, difficulties far transcending those relating to research in dead matter; nor do they recollect that many of the more common phenomena of dead matter are still inadequately explained. What, for example, is the real nature of elasticity; what occurs in dissolving a little sugar or common salt in water; what is electrical conductivity? In no domain of science, except in mathematics, is our knowledge absolute; and physiology shares with the other sciences the possession of problems that, if I may use a paradox, seem to be more insoluble the nearer we approach their solution.

The body of one of the higher animals—say that of man—is a highly complex mechanism, consisting of systems of organs, of individual organs, and of tissues. Physiologists have been able to give an explanation of the more obvious phenomena. Thus locomotion, the circulation of the blood, respiration, digestion, the mechanism of the senses, and the general phenomena of the nervous system have all been investigated, and in a general way they are understood. The same statement may be made as to the majority of individual organs. It is when we come to the phenomena in the living tissues that we find ourselves in difficulties. The changes happening in any living cell, let it be a connective tissue corpuscle, or a secreting cell, or a nerve cell, are still imperfectly understood; and yet it is upon these changes that the phenomena of life depend. This has led the more thoughtful physiologists in recent years back again to the study of the cell and of the simple tissues that are formed from cells. Further, it is now recognized that if we are to give an adequate explanation of the phenomena of life, we should study these, not in the body of one of the lower organisms, as was at one time the fashion, where there is little if any differentiation of function—the whole body of an amœboid organism showing capacities for locomotion, respiration, digestion, etc.—but in the specialized tissue of one of the higher animals. Thus the muscle cell is specialized for contraction, and varieties of epithelium have highly specialized functions.

But when cells are examined with the highest microscopic powers, and with the aid of the highly elaborated methods of modern histology, we do not seem to have advanced very far toward an explanation of the ultimate phenomena. There is the same feeling in the mind of the physiologist when he attacks the cell from the chemical side. By using large numbers of cellular elements, or by the more modern and fruitful methods of micro-chemistry, he resolves the cell-substance into proteids, carbohydrates, fats, saline matter and water, with possibly other substances derived from the chemical changes happening in the cell while it was alive; but he obtains little information as to how these proximate constituents, as they are called, are built up into the living substances of the cell. But if we consider the matter it will be evident that the phenomena of life depend on changes occurring in the interactions of particles of matter far too small even to be seen by the microscope. The physicist and the chemist have not been content with the investigation of large masses of dead matter, but to explain the many phenomena they have had recourse to the conceptions of molecules and atoms and of the dynamical laws that regulate their movements. Thus the conception of a gas as consisting of molecules having a to-and-fro motion, first advanced by Krönig in 1856 and by Clausius in 1857, has enabled physicists to explain in a satisfactory manner the general phenomena of gases, such as pressure, viscosity, diffusion, etc. In physiology few attempts have been made in this direction, probably because it was felt that data had not been collected in sufficient numbers and with sufficient accuracy to warrant any hypothesis of the molecular structure of living matter, and physiologists have been content with the microscopic and chemical examination of cells, of protoplasm, and of the simpler tissues formed from cells. An exception to this general remark is the well-known hypothesis of Du Bois-Reymond as to the existence in muscle of molecules having certain electrical properties, by which he endeavored to explain the more obvious electrical phenomena of muscle and nerve. The conception of gemmules by Darwin and of biophors by Weismann are examples also of a hypothetical method of discussing certain vital phenomena.

The conception, however, of the existence in living matter of molecules has not escaped some astute physicists. The subject is discussed with his usual suggestiveness by Clerk Maxwell in the article Atom in the "Encyclopædia Britannica" in the volume published in 1875, and he places before the physiologist a curious dilemma. After referring to estimates of the diameter of a molecule made by Loschmidt in 1865, by Stoney in 1868, and by Lord Kelvin (then Sir W. Thomson) in 1870, Clerk Maxwell writes:

"The diameter and the mass of a molecule, as estimated by these methods, are, of course, very small, but by no means infinitely so. About two millions of molecules of hydrogen in a row would occupy a millimeter, and about two hundred million million millions of them would weigh a milligramme. These numbers must be considered as exceedingly rough guesses; they must be corrected by more extensive and accurate experiments as science advances; but the main result, which appears to be well established, is that the determination of the mass of a molecule is a legitimate object of scientific research, and that this mass is by no means immeasurably small.

"Loschmidt illustrates these molecular measurements by a comparison with the smallest magnitudes visible by means of a microscope. Nobert, he tells us, can draw 4,000 lines in the breadth of a millimeter. The intervals between these lines can be observed with a good microscope. A cube, whose side is the 4000th of a millimeter, may be taken as the *minimum visible* for observers of the present day. Such a cube would contain from 60 to 100 million molecules of oxygen or of nitrogen; but since the molecules of organized substances contain on an average about fifty of the more elementary atoms, we may assume that the smallest organized particle visible under the microscope contains about two million molecules of organic matter. At least half of every living organism consists of water, so that the smallest living being visible under the microscope does not contain more than about a million organic molecules. Some exceedingly simple organism may be supposed built up of not more than a million similar molecules. It is impossible, however, to conceive so small a number sufficient to form a being furnished with a whole system of specialized organs.

"Thus molecular science sets us face to face with physiological theories. It forbids the physiologist from imagining that structural details of infinitely small dimensions can furnish an explanation of the infinite variety which exists in the properties and functions of the most minute organisms.

"A microscopic germ is, we know, capable of development into a highly organized animal. Another germ, equally microscopic, becomes when developed an animal of a totally different kind. Do all the differences, infinite in number, which distinguish the one animal from the other arise each from some difference in the structure of the respective germs? Even if we admit this as possible, we shall be called upon by the advocates of pangenesis to admit still greater marvels. For the microscopic germ, according to this theory, is no mere individual but a representative body, containing members collected from every rank of the long-drawn ramification of the ancestral tree, the number of these members being amply sufficient not only to furnish the hereditary characteristics of every organ of the body and every habit of the animal from birth to death, but also to afford a stock of latent gemmules to be passed on in an inactive state from germ to germ, till at last the ancestral peculiarity which it represents is revived in some remote descendant.

"Some of the exponents of this theory of heredity have attempted to elude the difficulty of placing a whole world of wonders within a body so small and so devoid of visible structure as a germ by using the phrase structureless germs. Now one material system can differ from another only in the configuration and motion which it has at a given instant. To explain differences of function and development of a germ without assuming differences of structure is, therefore, to admit that the properties of a germ are not those of a purely material system."

The dilemma thus put by Clerk Maxwell is (first) that the germ cannot be structureless, otherwise it could not develop into a future being, with its thousands of characteristics; or (second) if it is structural it is too small to contain a sufficient number of molecules to account for all the characteristics that are transmitted. A third alternative might be suggested, namely, that the germ is not a purely material system, an alternative that is tantamount to abandoning all attempts to solve the problem by the methods of science.

It is interesting to inquire how far the argument of Clerk Maxwell holds good in the light of the knowledge we now possess. First, as regards the *minimum visible*. The smallest particle of matter that can now be seen with the powerful objectives and compensating eyepieces of the present day is between the one-four hundred thousandth and the one-five hundred thousandth of an inch, or one-twenty thousandth of a millimeter in diameter, that is to say, five times smaller than the estimate of Helmholtz of one-four thousandth of a millimeter. The diffraction of light in the microscope forbids the possibility of seeing still smaller objects, and when we are informed by the physicists that the thickness of an atom or molecule of the substances investigated is not much less than a millionth of a millimeter, we see how far short the limits of visibility fall of the ultimate structure of matter.

Suppose, then, we can see with the highest powers of the microscope a minute particle having a diameter of one-twenty thousandth of a millimeter, it is possible to conceive that some of the phenomena of vitality may be exhibited by a body even of such small dimensions. The spores of some of the minute objects now studied by the bacteriologist are probably of this minute size, and it is possible that some may be so minute that they can never be seen. It has been observed that certain fluids derived from the culture of micro-organisms may be filtered through thick asbestos filters, so that no particles are seen with the highest powers, and yet those fluids have properties that cannot be explained by supposing that they contain toxic substances in solution, but rather by the assumption that they contain a greater or less number of organic particles so small as to be microscopically invisible. I am of opinion, therefore, that it is quite justifiable to assume that vitality may be associated with such small particles, and that we have by no means reached what may be called the vital unit when we examine either the most minute cell or even the smallest particle of protoplasm that can be seen. This supposition may ultimately be of service in the framing of a theory of vital action.

Weismann in his ingenious speculations has imagined such a vital unit to which he gives the name of a biophor, and he has even attempted numerical estimates. Before giving his figures let us look at the matter in another way. Take the average diameter of a molecule as the millionth of a millimeter, and the smallest particle visible as the one-twenty thousandth of a millimeter. Imagine this small particle to be in the form of a cube. Then there would be in the side of the cube, in a row, fifty such molecules, or in the cube $50 \times 50 \times 50 = 125,000$ molecules. But a molecule of organized matter contains about fifty elementary atoms. So that the 125,000 molecules in groups of about fifty would number $125,000 \div 50 = 2,500$ organic particles. Suppose, as was done by Clerk Maxwell, one half to be water; there would remain 1,250 organic particles. The smallest particle that can be seen by the microscope may thus contain as many as 1,250 molecules of such a substance as a proteid.

Weismann's estimates as to the dimensions of the vital unit to which he gives the name of biophor may be shortly stated. He takes the diameter of a molecule at one-two millionth of a millimeter (instead of the one-millionth) and he assumes that the biophor contains 1,000 molecules. Suppose the biophor to be cubical, it would contain ten in a row, or $10 \times 10 \times 10 = 1,000$. Then the diameter of the biophor would be the sum of ten molecules, or one-two millionth $\times 10 =$ ten-two millionths or one-two hundred thousandth of a millimeter. Two hundred biophors would therefore measure two hundred-two hundred thousandths or one one-thousandth mm. or 1 μ (micron = one one-thousandth mm.). Thus a cube one side of which was 1 μ would contain $200 \times 200 \times 200 = 8,000,000$ biophors. A human red blood corpuscle measures about 7.7 μ; suppose it to be cubed, it would contain as many as 3,652,264,000 biophors.

Now if the smallest particle that can be seen (one-twenty thousandth mm.) may contain 1,250 molecules, let us consider how many exist in a biophor, which we may imagine as a little cube, each side of which is one-two hundred thousandth mm. There would then be five in a row of such molecules, or in the cube $5 \times 5 \times 5 = 125$ molecules; and if the half consisted of water, about sixty molecules.

Let us apply these figures to the minute particles of matter connected with the hereditary transmission of qualities. The diameter of the germinal vesicle of the ovum is one-twentieth of a millimeter. Imagine this a little cube. Taking the diameter of an atom at one-one millionth of a millimeter, and assuming that about fifty exist in each organic molecule (proteid, etc.), the cube would contain at least 25,000,000,000,000 organic molecules. Again, the head of the spermatozoid, which is all that is needed for the fecundation of an ovum, has a diameter of about one-two hundredth mm. Imagine it to be cubed; it would then contain 25,000,000,000 organic molecules. When the two are fused together, as in fecundation, the ovum starts on its life with over 25,000,000,000,000 organic molecules. If we assume that one half consists of water, then we may say that the fecundated ovum may contain as many as about 12,000,000,000,000 organic molecules. Clerk Maxwell's argument that there were too few organic molecules in an ovum to account for the transmission of hereditary peculiarities does not apparently hold good. Instead of the number of organic molecules in the germinal vesicle of an ovum numbering something like a million, the fecundated ovum probably contains millions of millions. Thus the imagination can conceive of complicated arrangements of these molecules suitable for the development of all the parts of a highly complicated organism, and a sufficient number, in my opinion, to satisfy all the demands of a theory of heredity. Such a thing as a structureless germ cannot exist. Each germ must contain peculiarities of structure sufficient to account for the evolution of the new being, and the germ must therefore be considered as a material system.

Further, the conception of the physicist is that molecules are more or less in a state of movement, and the most advanced thinkers are striving toward a kinetic theory of molecules and of atoms of solid matter which will be as fruitful as the kinetic theory of gases. The ultimate elements of bodies are not freely movable each by itself; the elements are bound together by mutual forces, so that atoms are combined to form molecules. Thus there may be two kinds of motion, atomic and molecular. By molecular motion is meant "the translatory motion of the centroid of the atoms that form the molecule, while as atomic motion we count all the motions which the

*Opening Address by Prof. John G. McKendrick, M.D., LL.D., F.R.S., President of the Section, before the British Association at Glasgow.

atoms can individually execute without breaking up the molecule. Atomic motion includes, therefore, not only the oscillations that take place within the molecule, but also the rotation of the atoms about the centroid of the molecule."*

Thus it is conceivable that vital activities may also be determined by the *kind* of motion that takes place in the molecules of what we speak of as living matter. It may be different in kind from some of the motions known to physicists, and it is conceivable that life may be the transmission to dead matter, the molecules of which have already a special kind of motion, of a form of motion *sui generis*.

I offer these remarks with much diffidence, and I am well aware that much that I have said may be regarded as purely speculative. They may, however, stimulate thought, and if they do so they will have served a good purpose, although they may afterward be assigned to the dust heap of effete speculations. Meyer writes as follows in the introduction to his great work on "The Kinetic Theory of Gases," p. 4: "It would, however, be a considerable restriction of investigation to follow out only those laws of nature which have a general application and are free from hypothesis; for mathematical physics has won most of its successes in the opposite way, namely, by starting from an unproved and unprovable, but probable, hypothesis, analytically following out its consequences in every direction, and determining its value by comparison of these conclusions with the result of experiment."

* Meyer, "Kinetic Theory of Gases." Translated by Baynes. London 1899, p. 5.

RECENT EXCAVATION OF THE TEMPLE OF AEGINA.

INCONTESTABLY one of the most important events of the current year in the world of art and archæology is the excavation of the well-known temple of Aegina by Prof. Furtwängler during the spring and summer. It had long been felt that the excavations made in and around this temple in 1811, which brought to light the famous gable groups long known and much discussed under the name of the Aeginetan marbles, could not be regarded as definitive. After some slight work done by the Greek Archæological Society in 1893, it was much mooted who should undertake the final excavation. Two considerations made it most fitting that this privilege finally fell to Professor Furtwängler—the general consideration that it would be difficult to find another man who possesses such a comprehensive and minute knowledge of all the remains of ancient Greece, and the particular consideration that he is the Director of the museum in Munich where the statues found in 1811 are lodged, and has recently made from the lumber-room of the museum certain important additions to the two groups.

Of course it was his especial desire and hope to find more statues or fragments which should bring the two groups nearer to completion; but no one understood better than he that there was only one way to secure this result, and this was the thorough clearing of the temple and the area adjacent to it. This is the modern method of excavation. The method of Cockerell and his associates was like fishing in turbid water, while Furtwängler's process was an application of the drag-net which nothing could escape. A striking example of the thoroughness of his process is the fact that six heads, five of which *may* belong to the gable groups (although this, with becoming prudence, is left undecided in the provisional report which has just appeared), were found at the bottom of a deep cistern near the east front of the temple, into which the rain water from the roof was conducted through an aperture in the pavement of the esplanade in front of the temple. Before reaching the cistern, the water had to fall through a rather spacious cave, in the rock floor of which the cistern was cut. It is an interesting fact that the excavators of 1811 had their quarters in this very cave, which at that time had an opening to the north, subsequently closed by accumulation of débris. Cockerell did not think to let down his line under his own bed, where Furtwängler's drag-net secured the prize. Whatever may be the final adjustment of the five heads just mentioned, it is practically certain that two other heads found in the propylon of the temple precinct belonged, one to the east gable and the other to the west. No one can doubt that Prof. Furtwängler would like to be able to take off some of the heads of the figures in the Munich Museum that were put upon them by the skillful hand of Thorwaldsen, and put in their place the heads just discovered. Athenian gossip has it that an expression of this most natural desire was met by the Greek authorities by a request for the return of the groups now in Munich. Whether request and counter-request have ever been expressed is more than doubtful, and at any rate there is no likelihood that any of these recently discovered heads will ever leave the Athenian Museum, where they now lie. Greece will henceforth remain the jealous custodian of the treasures which she knows how to appreciate.

But to return to the excavations themselves, which I visited two days ago. They have one great charm, viz., that they performed a limited task which it was possible after a few months to present to the world as a finished piece of work. Besides the completely cleared floor of the temple which makes the interior arrangement plainer than before, the foundation has been cleared down to bed rock. The propylon, the great altar, and several adjacent buildings have been excavated with a care which not only brings its own reward, but has yielded a considerable quantity of small finds from Mycenæan times down well into the fifth century. Into the details of any of these matters I will not go; but there is one most interesting result of the work which cannot be passed by. The temple has, to the surprise of the world, changed its name. The world has for more than half a century regarded nothing as more certain than that this was the Temple of Athena, and has sometimes smiled at the reappearance now and again of the name, "Temple of Jupiter Panhellenius," in certain books which thereby took on an antiquated appearance. It leaked out long ago that this name went out into all the world in consequence of a very shallow fraud practised by some of the younger and more frisky members of the excavation party of 1811 upon some of the more venerable members, which consisted in cutting the words *Διὶ Πανελληνίῳ* on a block of the cornice to the cella—an impossible place for the name of a temple to be actually cut, to say nothing of the fact that the cutting was done in a ridiculously superficial manner and with no expectation of deceiving. When however the fraud had deceived the venerable authorities and had passed along through Europe, the perpetrators of it had not the courage to expose it; but, for the last fifty years, it has been generally understood. The story has been told by Ross in his Archæologische Aufsätze, I., p. 241 ff., and elsewhere.

All books published in late years have called the temple the Temple of Athena. Not only is Athena the central figure in both gable groups, but in the church of St. Athanasius, not so very far from the temple, was seen a lintel block bearing the ancient inscription *ὅρος τεμένους Ἀθηναίας*. Then another stone was found with the same inscription, "a little farther off," Ross says. It is true that voices were from time to time raised against the validity of these grounds for the name. Prof. Paul Wolters, in the Mittheilungen des Deutschen Archæologischen Instituts in Athen, 1889 (p. 177 ff), pointed out the fact that Ross had been over-zealous in saying that the first of these inscriptions was found only a quarter of an hour from the temple. It is, in fact, over an hour away; and the second one, being quite near the city, is over an hour and a half distant from the temple. Quite recently another such boundary-stone has been found in the sea near the city. It ought to have been recognized as practically impossible that so many rather heavy stones should be carried so far, and their provenance ought to have been sought elsewhere than at the temple under discussion. In the American Journal of Archæology, 1893, Prof. F. B. Tarbell and Mr. W. N. Bates collected all the evidence available as to the connection of the subjects of the sculptures on various temples with the divinity worshiped in the temples. They appear to have had in mind some question in regard to the Aeginetan sculptures, as appears in a note on p. 19. Prof. Furtwängler himself, in his "Beschreibung der Glyptothek König Ludwig I. zu München," 1900 (pp. 86 and 157), had already declared that the presence of Athena in both gables was no proof that the temple was hers. He then thought it a temple of Herakles. But no serious and strenuous objection had been made of the current name; doubts only had been expressed, when all at once, with the recent excavations, the certainty came with a blaze of proof that the temple belonged to another divinity almost purely local and much inferior to the great goddess Athena.

First came three fragments of inscriptions, all of which seemed to contain parts of the name Aphæa, and then came a large block nearly six feet long and a foot high, with an inscription of three lines, saying: "When Cleœtas was priest, the house was built to Aphæa. The altar and the ivory [i. e., presumably, the wooden cultus statue adorned with ivory], were made in addition, and a wall built around." This inscription is Archaic Doric, and must be put well back into the sixth century. It cannot refer to the present temple, because three of the four fragments of the block containing it were found in the débris used for filling, at a considerable depth below the surface of the platform east of the temple, and down near the bedrock. The present temple, then, replaced at some time an older one of the same divinity on the same spot. Pausanias (ii., 30, 3) says that the Temple of Aphæa had inscribed on it a song of Pindar. Furtwängler naturally supposed that there was some special occasion for this, and what more fitting occasion could be found than the dedication of the temple itself, which replaced with pomp an older one antiquated or destroyed? The time of dedication would then probably be when Pindar was at the height of his popularity.

The new name of the temple, based as it is not only upon the complete inscription, but on the fragments of three others, will probably stand secure. One of the blocks is too large to have been transported very far. The only rift in the otherwise secure foundation is the fact that Pausanias, in mentioning the Temple of Aphæa, says: "It is on the way as you go up to the mountain of Zeus Panhellenios." It is true that this mountain of Zeus Panhellenios was once supposed to be the height on which stands the temple under discussion; but there is little room for doubt that it is the peak now known as the *ὄρος*, near the south point of the island, which dominates the whole island and affords a view not easily forgotten. It is, in fact, perfectly clear that Theophrastus means this mountain when, in discussing the signs of storms, he says that clouds settling upon Zeus Hellenios are a sign of rain. This very peak is used to-day in the same way as a weather gage. Taking the *ὄρος* as something fixed, one has generally believed, on the authority of Pausanias, that the ruined chapel of the Archangel Michael, which stands on an imposing and finely constructed terrace, near the bottom of the northern slope of the *ὄρος* occupies the site of the Temple of Aphæa. Several ancient inscriptions have been found there; none, however, giving the name of a divinity. It might be well to rummage a little more among the blocks which cover the ground here. Some decisive inscription might be the reward. But, as the case now stands, it is easier to believe that Pausanias was a "betrogener Betrüger" than that Furtwängler is in error in his identification of the Temple of Aphæa.

In the interest, however, of a complete statement of facts, I may say that Prof. Furtwängler is a little unjust as to the fitness of this place to be the location of the Temple of Aphæa. In citing the passage in the narrative of Antoninus Liberalis which describes the flight of Aphæa—who is a sort of double of Dictynna—from Crete, her touching at Aegina, and her taking refuge in a grove in which her temple was afterward set up, he denies the possibility of this region near the foot of the *ὄρος* ever having been a grove, calling it an "öde Felswüste." Two visits to the spot have left me with the opposite conviction. Several fig trees flourish on and about the terrace; and there is even now considerable humus there, in spite of a long process of denudation and washing-down of the soil to a slightly lower level since classical times. There is, moreover, a large cistern, or well rather, near the upper edge of the terrace, which seems fed by a perennial source at the bottom. I have, at any rate, in two different years—1894 and 1901—seen crowds of women washing there in September, before the fall rains. I set this down as something to be taken into consideration in case there should be a change of the kaleidoscope, and new possibilities at present not in sight should present themselves.

The new discovery will hardly contribute anything toward fixing more exactly the date of the famous temple. Furtwängler, to be sure, suggests a very plausible and extremely interesting connection of the building of the temple with an episode in the battle of Salamis. Herodotus, after giving the Athenian account of the beginning of the battle, adds: "The Aeginetans tell another story, and say that the ship which had gone over to Aegina to fetch the Aeacidæ brought on the battle, and that, furthermore, the phantom of a woman appeared to them, and, when she had appeared, she reviled them, saying: 'Wretches, how long are you going to keep backing water?' and urged them on, so that the whole Greek line heard her voice." Furtwängler accepts a suggestion of Salomon Reinach that this phantom woman was, according to the belief of the Aeginetans, none other than the goddess Aphæa, who looked down from the height on which her temple stood, and, beholding her island devotees in the throes of a dangerous crisis, inspired them to the deeds of valor which made their name resound throughout Hellas. Herodotus, even with his Athenian leanings, has to record the fact that the Aeginetans outstripped the Athenians in this battle, according to the general judgment. What an occasion this afforded them to devote their treasure to the erection of a fine temple to the goddess who had led them on that day to immortal glory! Well might they call in Pindar to add luster to the offering—Pindar, who, in his fourth Isthmian ode, also showed his predilection to praise the island whose "strong tower was high valor."

This most attractive weaving of history and myth to form a setting for the date of the temple will not, however, remove entirely a doubt created in the minds of many by the solid presence of the gable groups themselves, which make such an impression of antiquity. It is difficult to believe that, long after the group of Athena battling with the giants in the gable of the Old Athena temple on the Athenian Acropolis had been produced, with its tremendous life and energy, sculptors could have gone on making such stiff, expressionless figures at a place so hard by. The newly discovered sculptures at Delphi seem rather to increase this difficulty. Sculpture was beginning to throb with life everywhere in Greece. Could Aegina have been in an eddy? But it must be said that Furtwängler, who is a master in the field of sculpture, has long held to about this date, and is not being carried away by any fancy generated by his new discovery. After years of discussion, while there is no perfect agreement as to the date of the Aegina sculptures, the limits have been drawn more closely. It is, after all, a question of a decade or so. The time when Leake and Cockerell dated the temple at 600 B. C. is long past.—Rufus B. Richardson, in the Nation.

EARLY HOT WATER HEATING IN GREENLAND.

WHEN we investigate the early history of any invention, unless it is one which has been made possible only by recent discoveries, we are likely to unearth some surprising facts. One would hardly suppose, for example, that the heating of dwellings and churches by hot water originated in Greenland, yet such is the fact, if we may rely on the data given by a recent number of Cassier's Magazine, from which we quote below:

"An interesting example of the antiquity of the system of heating by means of hot water is cited by Mr. Frederick Tudor in a diminutive treatise on 'Heating for Health, or How to Heat a House,' which he prepared about ten years ago. Mr. Tudor tells that the announcement of the discovery of Greenland by Davis, in 1587, brought to light the fact that the territory had been discovered and colonized by the Norwegians, centuries before. The first European to land upon its shores was probably Leif, in the year 984, whose glowing accounts of its attractions led to the founding of a colony a year or two later. This flourished until, in the fourteenth century, it contained 190 villages, divided into twelve parishes with one bishop's see. Christianity had been introduced in the twelfth century, and a considerable intercourse was maintained with the mother country, Norway. The transfer of the latter to the crown of Denmark in 1387, its attachment to Sweden dating only from 1814, was the cause, probably, of neglect of the Arctic colony, and eventually intercourse ceased altogether, and the country and its people were forgotten. Doubtless there were occasional winters of great severity, and the inhabitants, languishing under the attacks of disease superadded to their hardships, perished without being able to make known their distressing condition.

"Davis found no trace of any previous occupation of Greenland, nor in later years were the Eskimos able to give any definite information concerning them, although historians had discovered proof that Greenland had once been a flourishing colony, and were unremitting in their efforts to prevail upon the Danish government to make a search for the lost colony. It was not until 1723, however, that an expedition was undertaken with this object. It was in August of that year that Egede, in command of the expedition, and while seeking for traces of the lost colonists, came upon a group of remarkable ruins at a place called Kakortok, in southwest Greenland. This has since been identified as Alba, which is spoken of by the ancient German author Dithmar Blefken, who tells us that in 1516 he met a Dominican monk in Iceland, who told him about the state of Greenland, and besides, 'several other things about St. Thomas's cloister, particularly that there was a fountain of hot water which was conveyed by pipes into all their apartments, so that not only their sitting rooms but also sleeping chambers were warmed by it, and that in the same water meat might be boiled as soon as in a pot over a fire.' This is also vouched for by Cæsar Longinus, in his 'Extracts of All Journeys and Voyages.' These old ruins, the earliest traces of Europeans in the Western hemisphere, were revisited as recently as 1888 by

the artist Bradford, who also found the hot water spring, which is of volcanic origin. This Mr. Tudor considers to be the first authentic example of the use of hot water for warming dwellings, though it was probably only a clever adaptation by the builders of the monastery of a method of conveying heat, which must have been previously known to them. Mr. Tudor himself says that it is not improbable that the men who could build those magnificent cathedrals without mortgages were both able to appreciate the merits of hot-water heating and to make efficient use of it by the aid of appropriate apparatus. As to the utilization, as described above, of the natural hot-water springs, it is not uninteresting to add here that piping such waters to the houses has been practised in more than one instance in recent years. In one old German town there is an installation of this kind going back beyond memory or record."

MODERN BEE-CULTURE.

THERE is little capital employed in agricultural enterprises that gives so large returns for the outlay as that invested in bee-culture. The farmer whose resources are very limited sees with pleasure, in autumn, a goodly number of dollars added, through his apiary, to the income of his humble exploitation, and that, too, with scarcely any labor on his part. As in agriculture, very important technical progress has been made in bee-culture in the last few years, and we now have many improved apicultural apparatus that are employed everywhere where the raising of bees is sufficiently developed to constitute an industry.

FIG. 1.—BAITED FRAME.

Beehives especially are now everywhere to be found of the most improved types. Everyone knows the common cone-shaped hive that has been used from the remotest times; and just as well known is the reckless method of employing it. A hole is made in the ground, a sulphur match is lighted therein, the hive to be stripped of honey is placed over it, and, in a few minutes, there no longer remains a single living bee. The honey and wax of this sacrificed colony can then be disposed of. This method is that of the savages spoken of by Montesquieu, who cut down a tree in order to gather its fruit. Nothing is more barbarous and, at the same time, more wasteful, since instead of the bee, the productive capital, being preserved in order to obtain an annual interest, such capital is destroyed.

The first progress made in bee-culture consisted in the use of a hive with a cover and having two stories. The lower story was both the insects' nursery and larder. It was therein that the queen bee laid all her eggs, the development of which kept the population busy, and in which the bees stored enough honey for their winter consumption. The upper story was the "granary," into which the bees put the surplus of their harvest. This is the part that the beekeeper despoiled for his personal profit. *Sic vos non vobis, mellificatis apis,* says Virgil. The beekeeper removed the cover, drove out the bees and then collected the honey and wax. The progress made, as may be seen, consisted in the fact that there was no longer any sacrifice of bees. The kinds of hives just mentioned are called "fixed hives," because the cakes of wax are fixed to the walls and summit and may be detached and replaced at will.

A further progress has been made in the invention of the hive with movable frames. Let us imagine four laths fixed to each other in such a way as to constitute a frame. The upper lath is provided with small prolongations, through which the frame is supported upon a ledge in the interior of the hive. In

FIG. 2.—THE LAYENS AUTOMATIC SMOKING APPARATUS.

this frame the bees form their comb. A certain number of such frames are arranged parallel with each other in an oblong box, and this constitutes the hive with frames. The box that contains these frames has no bottom, but rests upon a table, and is provided with a door for the entrance and exit of the bees. The vertical laths of the frame do not touch the side walls of the hive, and the frame does not descend as far as to the table. Therefore, the bees can easily pass at the bottom and sides from one frame to another in order to deposit their honey in the cells. Each of the frames, then, is isolated and movable. If it is desired to look into one of them, the bees are slightly smoked and the frame is lifted; and, then, with a feather or a brush, the insects are driven into the interior of their hive without the operator running any risk of being stung. The frame can then be removed from the hive, examined and put back into the latter, where it will soon be reoccupied. If the beekeeper desires to examine the entire hive in order, for example, to see how much honey it contains, he proceeds, as we have just said, with each frame in succession. With a little practice nothing is easier and less dangerous.

In order to make the bees work with regularity in the frames it is well to "bait" the latter; that is to say, to affix all along the length of the upper lath some fragments of a previously constructed comb (Fig. 1). The bees affix their new structures to these old pieces and construct a vertical and very regular comb.

We have spoken of smoking the bees. To this effect there is still frequently used a sort of bellows in the interior of which are burned old rags or any other material that produces much smoke. The inconvenience of this process is that the fire goes out if the blowing is discontinued. The beekeeper has therefore always one hand busied in operating the instrument. There has recently been devised an automatic smoking apparatus which is shown in Fig. 2.

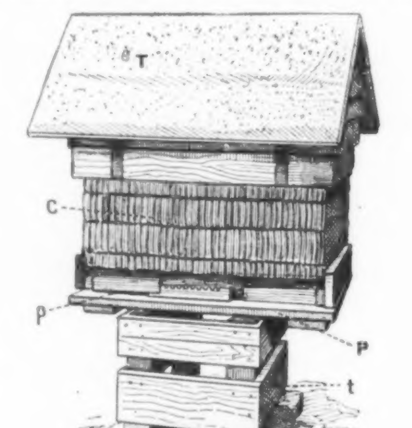


FIG. 3.—HORIZONTAL HIVE.

t, stand; *P*, table; *p*, fly-hole; *C*, body of the hive; *T*, roof.

At the back of this there is a clockwork movement which actuates four wings. In front there is a small chamber in which is placed the material that furnishes the smoke, and the instrument terminates in a sort of flattened nozzle that is easily inserted between two frames. The motion of the wings forces the smoke upon the bees; and as long as the wings are revolving the fire does not go out. It is therefore possible for the operator to place the apparatus near him and have both hands free. The key is turned from time to time to keep the instrument wound up.

The hive that we have just described, somewhat theoretically, has been constructed in many different forms, into the details of which we shall not enter. Suffice it to say that all may be referred to two distinct types. In one of these (Fig. 3) the frames are higher than wide, and are placed parallel with each other in the hive, which then has generally the form of a box of which the length is greater than the height, and is hence called a "horizontal hive." At the epoch of collecting the honey a certain number of the frames filled with the latter are removed, but

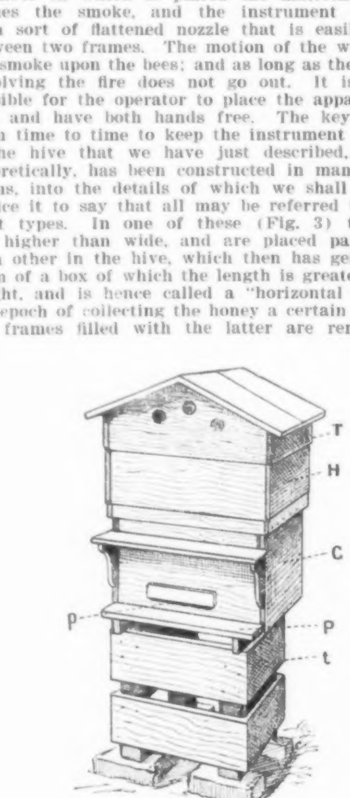


FIG. 4.—VERTICAL HIVE.

t, stand; *P*, table; *p*, fly-hole; *H*, upper story; *T*, roof.

care is taken to leave sufficient material for the winter food supply of the colony. The table of the hive is placed upon a stand so as to raise it slightly above the ground.

The other type (Fig. 4) is based upon the principle of the hive with a cover. As in the latter, there is a lower story for the reception of the hatching frames and winter provisions, and an upper story, which is placed upon the first shortly before the gathering of the full crop. This is the "granary," and the honey that the bees accumulate therein is the bee-culturist's portion. When this part of the hive is full it is simply removed from the under story. The latter is covered with oilcloth and the roof or cover that protects the whole is put in place.

In this type of hive the frames of the lower story are wider than high, and, on account of the superposition of the stories, the hive is called "vertical."

The discussion of the respective advantages and disadvantages of these two sorts of hives has caused beekeepers to waste gallons of ink, and after reading the polemics devoted to this subject we are able to say that if bee-culturists have not always borrowed honey from the bee they have at least sometimes borrowed its sting. As for us, we shall not venture to enter the lists. An experienced beekeeper will derive all the profit possible from either of the hives.

An apiary consists of a collection of hives of one system or the other, or even of several systems, and the number of hives assembled at the same point may be greater or less according as the vicinity is more or less melliferous.

As will presently be seen, the movable frame has other advantages than the facility with which it permits of an inspection of the hive or of collecting the honey. In order to put such advantages to profit various ingenious inventions have been made.

In order to extract the honey from the cells constructed in the fixed hives the comb is submitted to the action of a press. The honey obtained is afterward purified, as is also the wax. This latter certainly produces a revenue, but numerous experiments have shown that the bee, in order to secrete a certain weight of wax, is obliged to consume a quantity of honey of which the value is greater than that of the wax produced. The bees evidently have to construct cells in which to store their honey, and it would never occur to anyone to suppress a function indispensable to the insect—that of the secretion of wax. But is it not possible to regulate this within certain limits? Would it not prove advantageous, while permitting the bees to build, to furnish them with structures that are at least begun, or even finished, in order to permit them to store their honey sooner? Such questions have been answered affirmatively in the invention of what is called comb foundation. This consists of sheets of pure beeswax the two sur-

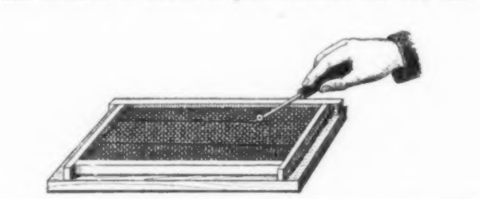


FIG. 5.—FRAME PROVIDED WITH A SHEET OF FOUNDATION WAX.

faces of which are provided with depressions and reliefs which, as a whole, form bases for cells. Such sheets may be made upon a small scale, just as we make waffles. The wax is melted and a genuine waffle-iron, specially constructed for the purpose, is employed. But commerce furnishes such wax, which is manufactured upon a large scale by means of cylinders that are provided with the necessary impressions, and between which is passed the sheet of wax to be goffered.

These sheets are placed in the frames (Fig. 5), and all that the bees have to do is to raise the walls of the cells in order to form a complete comb. Thus a part of the total wax has been furnished to them, and a part of their work has been done mechanically. In addition, the movable frame permits of extracting the honey without breaking the comb; and after it

FIG. 6.—EXTERNAL VIEW OF A HONEY EXTRACTOR.

has been emptied it is given back to the bees. In fact, when a frame is taken from the hive to be emptied it should have the greater portion of its honey "operculated." To explain what this means: The nectar that the bees obtain from flowers contains a much greater proportion of water than honey does. It ought therefore to lose through evaporation a large percentage of its aqueous contents. The bees are so well aware of this that in the evening, after a day's collecting, many of them gather at the entrance of the hive and flap their wings with great rapidity. The strong current of air thus produced hastens the evaporation of the nectar. When the honey is "ripe," to use a common expression, the bee deposits therein a drop of its venom, which contains

formic acid. The effect of this is doubtless to prevent any fermentation of the saccharine liquid. Then the insects close each cell with a slightly concave piece of wax, or, to use a common expression, "put an operculum" upon it; hence the name of "operculated honey" given to the perfect product inclosed in a tight cavity. Later on, in order to feed upon such honey, the bees gnaw away the operculum and thus open the cell. The honey must not be collected until it is in great part operculated, since otherwise, still containing too much water, it would be apt to ferment and spoil.

After the frames have been removed from the hive the collecting of the honey comprises three operations: "Disoperculation," "extraction" and "purification."

Disoperculation.—In order to perform this operation there is used a wooden horse that carries two small supports for the extremities of the laths that constitute the upper side of the frame. A special knife carries a handle at each extremity and requires the use of both hands for its manipulation. The blade of this is heated in hot water or upon a stove in order to melt the wax a little and render the disoperculation easier. The two extremities of the blade are placed upon the side laths of the frame, and, the knife being moved downwardly, the entire upper portion of the

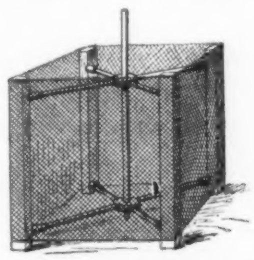


FIG. 7.—THE FOUR WIRE LATTICES OF THE HONEY EXTRACTOR.

cells is cut from one side and the other of the frame. The fragments fall into a large basin placed under the horse, and must not be lost, since they are formed of honey and wax.

Extraction.—The disoperculated comb is placed in an apparatus called a honey extractor (Fig. 6), the principle of which is the same as that of a hydroextractor. In the interior of a cage there revolve around one axis in common four wire lattices connected with each other, and of the size of one of the frames (Fig. 7). Four disoperculated frames are placed against the internal face of the lattices, and the whole is made to revolve rapidly through a train of gear wheels; whereupon the honey is thrown out of the cells through centrifugal force. Upon reversing the position of the frames and resuming the operation the honey is ejected from the other face of the wax. The honey collects at the bottom of the extractor, and is drawn off through a cock.

Let us remark that the comb thus treated still contains a little honey, and so at the end of the day it is put back into the hive, where the bees lick it and free it from all the particles of wax detached from the constructions and render it fit to receive a new deposit.

Purification.—The honey removed from the extractor contains numerous particles detached from the wax at the moment of disoperculation and extraction. In order to free it from such impurities it is put into high and narrow vessels called purifiers. The wax, which is lighter, rises progressively to the top, from which it is easily removed, and the perfectly pure honey is drawn off from the bottom by means of cocks.

This honey is put into pots. In the cells, and for a certain length of time after purification, the product has a sirupy consistency; but it gradually undergoes a sort of imperfect crystallization, becomes solid

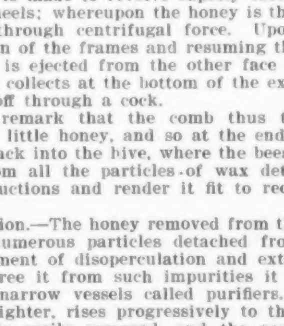


FIG. 8.—SECTIONAL FRAME.

and assumes a granular consistency and then constitutes what is called "granulated honey." It is in this form that it is very frequently found in the market as a food product. Nevertheless, what is called "honey in the comb" is oftener sold and eaten.

Let us say that a combination of small juxtaposed frames called "sections" (Fig. 8) is often substituted for the ordinary frames in beehives. In these frames, the dimensions of which are such that the comb obtained weighs about eight ounces, the bees do their constructing; and in various countries, especially in America, where more honey is eaten as a dessert than in France, the product is served almost exclusively in the form of sections. When the latter are very regularly constructed they have a very elegant aspect. The inconvenience is that the walls of these numerous little frames discommode the bees, and the quantity of honey obtained is greatly reduced; so honey in sections costs, weight for weight, much more than ordinary comb honey or granulated honey in pots.

From the viewpoint of consumption as human food honey has lost much importance since antiquity, cane and beet sugar having dethroned it. Its uses are nevertheless numerous, and every beekeeper can easily find a market for his product. If to these be added those of the wax for the waxing of floors, the manufacture of varnishes, encaustics, tapers, etc., we must conclude that bee-culture has a clearly indicated place, though modest it be, in the agricultural industries.—For the above particulars and the illustrations we are indebted to the Revue Universelle.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Tangential Traction.—The following translation of an article from the Madrid Mining Review on a so-called new and ingenious system of electric traction has been transmitted by Consul Ridgely, of Malaga, under date of November 7, 1901:

We have received a pamphlet issued by the Société Anonyme Electricité et Hydraulique, of Charleroi, treating of the new and highly ingenious system of electric traction devised by Messrs. Dulait, Rosenfeld & Zelenay.

It is a clear and precise résumé, and we subjoin a translation thereof, confident of its being read with the interest it deserves.

Tangential traction is based upon the application of polyphasic alternating currents. The most characteristic feature of this system lies in the complete absence of a rotating motor in the carriage, and in the absence of obstacles to currents between the vehicle and the source of electric energy.

The motion of the carriage is obtained under the influence of the magnetic "traveling" field, whose action is as follows: It is known that in polyphasic motors in general there exists no electric connection between the rotating part, called the "rotor," and the stable part, called the "stator." In consequence of the combination of polyphasic currents thrown into the stator, a magnetic current is produced in the magnetic field, which is rotary. This field, owing to the reactions produced in the rotor, impels the latter, imparting to it a rotary movement. If we develop upon a plane the inductor of such a motor, and suspend above the apparatus inducted by it and similarly developed, the rotary movement is transformed into rectilinear motion. We may point out that the developed inducted apparatus need not of necessity cover the whole length of the inductor.

Having said this much, let us consider a vehicle placed on two rails; let us fix between the rails the developed inductor called stator, and let us suspend beneath the vehicle the developed inducted apparatus called "propeller." This vehicle will be put in motion when a polyphasic current is produced in the stable part of the system; that is, in the stator. In these conditions the magnetic field is no longer gyratory, but continuous.

Having once expounded the principle of this new system of traction, we proceed to meet the objections that immediately present themselves to the mind.

In order to attain economy, both as to production and construction, in polyphasic motors, the object aimed at is to reduce as much as possible the free space between the rotor and the stator. Sometimes this space does not exceed a fraction of a millimeter. It is needless to say that in the industrial applications of tangential traction so small a distance between the stator and the propeller will constitute a great drawback, and may perhaps also render the regular action of the system practically impossible. For this reason we have devised a new arrangement, which shall allow of an enlargement of the intervening space just referred to and at the same time of a considerable reduction in the copper to be employed. The very painstaking investigations to which we applied ourselves for this purpose have given us entire satisfaction and demonstrated the feasibility of the plan as applied to practice.

A second important consideration is as follows: In our explanation of the groundwork of the system we have supposed the stator to be stable between both rails throughout the length of the line and the triphasic current to circulate throughout the length of the stator. It is evident that such an arrangement would not, from a practical and economical standpoint, be realizable on an extensive line on which rather broad trains should circulate. In order to overcome this difficulty we have essayed to break up the stator into sections and to feed these latter by means of "feeders." This subdivision into sections would be unnecessary if the propeller covered the stator completely, because in such case the system would be nothing but an immense motor developed upon the surface of the ground. Calculations show that, as applied to railroads, sections of 500 meters (1,640 feet) would give a very satisfactory result; the length of the sections depends simply upon the intensity of traffic. Each section's entrance into the circuit, as also its elimination therefrom, would be effected electrically and automatically by the train itself, or by means of a special arrangement which we have tried practically.

The trials we have made have led us to employ the discontinuous stator, which renders the application of the system economical. We are already in a position to forecast that, as a rule, it will be sufficient to furnish the line with stators at about every fifth of its length.

Finally, we would remark that the construction of the stators can be so managed that the consumption of energy shall be almost constant at all points of the line, whether on slopes or on level ground. Indeed, it is a known fact that by varying the length of the poles of a triphasic motor the velocity of the latter is acted upon.

It would be difficult to estimate thus early the importance of possible applications of tangential traction. We will, for the present, confine ourselves to stating the fact that one of its great advantages consists in the direct use of high-tension currents, without any contact of these with the exterior, whereby, on the one hand, causes of danger and, on the other, the difficulties resulting from the system of lateral intaking of current are eliminated.

The mode of traction is advantageous in all respects, seeing that it is independent of the adherence of the train; in it we witness a power which continually impels the vehicle on a parallel with the line, and in accordance with its axis. Besides, there is a suppression of all mechanical transformation of motion, thus allowing of a considerable increase in the present velocities of trains. Security in the running of trains will be complete, inasmuch as perturbing movements, such as full speed, starting, etc., will no longer exist, while there will be but one continuous motion of the carriage toward the stator.

Tangential traction will likewise reduce to a minimum the expense of maintenance, both of movables and fixtures, owing to the absence of organs of mechanical transmission and of perturbing movements.

With a view to impart fixity to ideas as to the economical advantages of tangential traction, we have elaborated two projects for the service of trains on one and the same line, 50 kilometers (31 miles) long, from Brussels to Antwerp—the first for realization by means of electric traction with lateral intaking of current, and the second by means of tangential traction. Assuming the expense of installation in both projects to be equal, the industrial production of the line under the system of lateral intaking of current is about 37 per cent, whereas 60 per cent is attained under the system of tangential traction. This calculation proves that, by increasing the length of the line and the weight and velocity of the trains, the advantage in favor of tangential traction is still more considerable.

Opening for American Machinery in Bohemia.—Nearly everything made in the United States could be sold in this district (Reichenberg), but the greatest opportunity of all is for spinning and weaving machinery. In previous reports I have noted the absence of American machinery in Bohemia. Of the approximately 2,000,000 flax, wool and cotton spindles and of the many thousand looms operating in this district, not one was made in the United States. Our consuls have at sundry times sought to change this condition by opening correspondence with makers of such machinery in the United States, but have never been able to persuade the latter to enter aggressively into the field. It is true they have always been ready and willing to fill orders, but unfortunately a merely receptive state does not answer. Most of the factory machinery in this district comes from Great Britain, some from Germany, and a small part is of local production. The field is so great as to be worth a vigorous and persistent effort to get a footing in it; but nothing can be done with circulars and trade periodicals, especially when printed in English. Industrious, German-speaking agents are essential; it would be better still to have resident agents on the ground, able to keep a watchful eye on the situation and to be constantly in close touch with factories.

During the past summer a firm at Dresden, Germany, advertised American farm machinery in a Reichenberg newspaper. Soon thereafter, and possibly as a result thereof, I saw an American mower at work in a neighboring meadow—the first and only American machine I have seen in this district. But it is an entering wedge, and inspires hope for the future.

No reaper has yet invaded a grain field in this section, the sickle still holding sway in the harvesting of cereals, and thrashing is still done with the flail, wielded by women, who work in quartettes.—Frank W. Mahin, Consul at Reichenberg.

Proposed Electric Tramway at Northampton.—Consul McFarland reports from Nottingham, October 26, 1901:

The horse tramway system of Northampton, which was established by a private company in 1881, was this week taken over under purchase by the Northampton corporation, at a transfer price of £37,500 ($182,493.75). The working hours of employés have been reduced and other reforms instituted; but the purpose of the city in acquiring the plant is to convert it into an electric system, and enlarge it to suit the needs of the locality. This conversion of private into public tramway enterprises is proceeding generally throughout England, and in every instance so far has been preliminary to the institution of modern electric service.

Proposed Lessening of German Sugar-Beet Production.—The following translation from the Frankfurter Zeitung has been forwarded by Vice-Consul-General Murphy, of Frankfort:

The supervising committee of the German sugar syndicate decided at its last meeting to use its influence—owing to the depressed condition of the sugar market, which can be bettered only by lessening production—for the purpose of reducing the cultivation of beets in 1902. An effort will be made to effect an international agreement on this subject. According to the organ of the ring (The German Sugar Industry), at the meeting referred to, the opinion was expressed from all sides that the decline in the price of beets will cause the planting of fewer beets in future. Time will show whether this view is a correct one. So long as the government assists the industry with bounties and in other ways, a normal development of the business of raising beets can hardly be expected. The overproduction, which it is now desired to combat, has been artificially caused or at least encouraged.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

To Make Photos Transparent.—Heat 40 grammes of paraffine and 10 cubic centimeters of linseed oil to 18 deg. C. and dip the picture into this. Then lay it between blotting paper under pressure to remove the superfluous solutions. Such pictures may be attached to glass with 100 cubic centimeters of syndeticon and 26 grammes of sugar. There are various kinds of paraffine having different melting points, from 30 to about 60 deg. C. Hence it is advisable, in order not to generate any superfluous heat, to carefully warm the paraffine until it melts and can be intimately mixed with the linseed oil.—Deutsche Photographen Zeitung.

Blacking Powder for Shoemakers.—

Dehydrated green vitriol	600
Finely powdered logwood extract	80
Potato starch	80
Frankfort black	40
Powdered oxalic acid	30
Powdered yellow potassium chromate	12
Aniline black, water-soluble	12

Mix the above ingredients. For the preparation of an excellent black polish for the edges of soles and heels dissolve 100 of the powder in 1 liter of boiling water.

Alcohol Briquettes.—Alcohol briquettes are little cans of tin plate which are filled with a yellowish, combustible mass and can be used like an alcohol lamp. The flame is extinguished by simply covering up the can. The contents may be kept for any length of time until exhausted. The pasty substance forming the filling can be readily prepared, and is obtained in the following manner: In a vessel of sufficient size heat 1 liter of alcohol on the water bath. As a general rule, denaturized alcohol is used. When the liquid has been heated to 60 deg. C., 30 grammes of grated and dry Venetian soap and 2 grammes of shellac are added. The liquid is then stirred until the admixtures have completely dissolved, and is thereupon poured into the cans, which are closed up immediately. On cooling the mixture becomes solid.—Seifensieder Zeitung.

Innovation in the Automobile Industry.—Much interest has been excited in automobile circles by the endeavors of constructors to use the benzine motor and the electro-motor simultaneously for the propulsion of automobiles. This combination system has also been applied to transportable charging stations by coupling a small benzine motor to a dynamo, impelling the latter by means of the benzine motor. The whole plant takes up little room and can be transported anywhere without much trouble.

It may happen, however, that such a charging station has to be used in a lively place. For such stations it would be preferable not to couple the dynamos with a benzine motor, but with a small steam engine. The noiseless, uniform, shockless running of the steam engine speaks in favor of this system. It signifies a saving of the dynamos and of the battery to be charged. Such a steam and electric automobile would offer many advantages for charging the accumulators of electromobile cabs, especially at the places where they are stationed.—Neueste Erfindungen und Erfahrungen.

Painting of Canvas.—The object of painting tent-cloth, sail cloth and other fabrics is a two-fold one, viz., to render them resistive to all outside influences, such as rain, wind, etc., and on the other hand, to preserve the softness and pliancy of the stuff for years, says Chr. Mangold in the Maler Zeitung.

These requirements can be met by a coating with specially prepared linseed oil varnishes, which in part readily penetrate into the fibers, dry well and quickly, and harden nicely, but in such a manner that the material will never lose flexibility.

If one desires to prepare the varnish one's self, an iron kettle should be filled, but not entirely, with good matured linseed oil and placed upon the fire. When the oil has reached the boiling point, continue the firing, until an immersed thermometer registers about 260 to 270 deg. C. and ill-smelling, grayish white vapors arise. At this temperature the oil is maintained for about 4 hours without any increase, which, by the way, is liable to occur readily. Then the temperature is increased to 290 deg. C., and when this is reached, the fire is extinguished. Now allow the thickened varnish to cool to about 130 deg. C., but start the fire again under the kettle and add, very slowly, with constant stirring, 2 per cent of the entire oil-quantity of manganoas borate. The whole is still boiled for about 2 hours at 130 to 150 deg. C. and next left to rest completely for clarification.

In eight to ten days the same is accomplished, and two parts of this mixture are mixed with one part of turpentine oil, but preferably in the warm to obtain an intimate intermixture.

All canvas to be painted must first receive a priming with ordinary starch paste, and as soon as this is dry, the varnish-turpentine-oil mixture is applied twice, but very thinly.

If the paste priming, which prevents the varnish mixture from entering the pores, is omitted, there would be danger of the canvas, after all, becoming hard and brittle in time.

The purpose of painting the canvas, as stated, is to secure it against all influences, so that it remains flexible and does not break. If the stuff after having been saturated with varnish is still to be painted with a top color, take paint ground with linseed oil and thin it into painting consistency with the above mixture, putting on two or three or even four very thin coats.

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